Australasian Plant Conservation

Bulletin of the Australian Network for Plant Conservation Inc

Volume 30 Number 2 September – November 2021

Including articles on orchids, plant responses to fire, myrtle rust and more!

ANPC INC. MISSION STATEMENT: To promote and improve plant conservation

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Front cover: Buttercup Doubletail orchid. Photo: Laura Canackle, DPIE

Printed by: Flash, Canberra.

Australasian Plant Conservation

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Australasian Plant Conservation is produced by the ANPC Inc. with assistance from the Australian National Botanic Gardens.

Australasian Plant Conservation is printed on recycled paper.

ISSN 1039–6500

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This issue

Regular features

From the editor

HEIDI ZIMMER

Welcome to the spring issue of Australasian Plant Conservation! I hope you have been able to visit the bush, now bursting into bloom – the rain and fires have contributed to spectacular flowering of some species. We begin this issue with articles on orchids in partnership with the Orchid Conservation Symposium which was held in June. First, Tara Hopley and others describe the value of genomics for guiding conservation action for the Endangered *Diuris fragrantissima* in Victoria. They sampled plants growing *in situ* (in the wild) and the *ex situ* collection at the Royal Botanic Garden Victoria. Their results will provide guidance for artificial crossing to maintain *ex situ* collections, and for future introductions – so that they can incorporate the overall genetic variation present. Continuing with the theme of genomics and orchids, the next article is from Heidi Zimmer (me), and provides an overview of a study on the *Corybas aconitiflorus* complex by Natascha Wagner *et al*., published earlier this year in the journal *Conservation Genomics*. The study provides insights into the relationships among plants, populations and species within the *Corybas aconitiflorus* complex – and importantly highlights the utility of genomic approaches in threatened species conservation.Next, we move to an article by Laura Canackle on the Endangered *Diuris aequalis*, and the high numbers of this species found this year – attributed to both fire and rainfall. Staying with the theme of orchids, we then have an article by Erika Roper, who describes findings from recent (second-year post-fire) surveys of *Genoplesium superbum,* and discusses the potentially interacting impacts of fire, herbivory and pollinators.

Shifting focus, the fifth article in this issue is from Stephen Bell and provides a thought-provoking discussion of the issues surrounding the listing of fire-ephemeral species under threatened species legislation. Do all plant species which are 'rarely seen' require listing as threatened? Stephen provides some useful guidance for conservation decision makers working in this area. This is followed by an article from Emma Bodley and Bec Stanley on an emerging and critical issue for plant conservation in Australia: Myrtle Rust. Emma and Bec detail the sentinel survey project at Auckland Botanic Garden from 2014 to 2021, highlighting the benefits of sentinel projects, not just in detection but also in awareness raising and teaching.

Leading our regular features, in news from the ASBP, Bradley Desmond and others walk us through some of the incredible achievements of Project Phoenix, which has been building and securing native seed and plant supply for landscape restoration, recovery and resilience in bushfire-affected areas – including collections from more than 100 priority taxa. Next, we return to our orchid theme, with Lucy Commander, who gives us a run down on the Orchid Conservation Symposium. This is followed by articles on two recently published and important publications for plant conservation; Lucy Commander and Christine Fernance then introduce us to the newly released Florabank Guidelines, and Amelia Martyn Yenson presents the new edition of the Germplasm Guidelines. We round out the issue with a member profile, news and conferences and research round up. Enjoy!

A genomic perspective helps guide conservation of an endangered orchid from south-eastern Australia

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Conserving adequate genetic diversity is considered crucial to *in situ* recovery (Commander *et al.* 2018) and genomics has become an important tool contributing to biodiversity management. The success of activities such as reintroduction and population augmentation of threatened orchids relies heavily on satisfying the species' biological requirements, including mycorrhizal associations and pollen vectors as well as ecological attributes (Phillips *et al.* 2020), but the long-term effect of genetic erosion may not be immediately apparent even when impacting a species genetic health and future persistence. For threatened species, conservation genomics has been applied largely to managing genetic resources *in situ*. However, a genomics approach can be applied to any group of plants where baseline information would be useful to guide conservation activities, for example, where manipulated breeding for seedling production may result in unintentional loss of diversity.

At the Royal Botanic Gardens Victoria (RBGV), we are using genomics to guide an artificial breeding program as part of the conservation for the Sunshine Diuris (*Diuris fragrantissima*) a nationally endangered orchid that exists largely in *ex situ* cultivation. It has become a focus for concerted conservation efforts by the community and government agencies due to the precipitous decline in plant numbers first reported almost a century ago. Our genomics study is one aspect of a conservation program for this species which in addition to artificial pollinations informed by our genetic diversity studies, includes the collection and storage of seed, identification of mycorrhizal diversity and distribution, and the symbiotic production of seedlings for reintroduction into a site supporting both pollinators and mycorrhizal fungi, all essential components for enabling natural reproduction *in situ*.

The species

The Sunshine Diuris is a terrestrial orchid once common in the grasslands of the dry, stony basalt plains north-west of Melbourne, Victoria. Plants are stout, 10–20 cm tall when in flower, and have two linear, channelled leaves 10–20 cm long. White with pale purple markings the flowers are erect and strongly fragrant (Figure 1). Originally described as *D. alba* R.Br., morphological similarity to other *Diuris* taxa has led to several taxonomic changes, the latest recognising the taxon as *D. fragrantissima* D.L. Jones and M.A. Clements (Clements and Jones 1989). By this stage, the species had undergone significant decline with a single population remaining. Recognition of *D. fragrantissima* at species rank is supported by previous phylogenetic and morphometric analysis (Smith 2006) and also in our study (data not shown).

The remnant population persists in a fenced area of 0.1 ha within a rail reserve in north-west Melbourne (Figure 2). It consists of 32 naturally occurring wild plants (in 2020) supplemented with ~100 plants grown at the RBGV either from seed produced *ex situ* or from hand pollination of wild plants. Several introductions have been undertaken at a second site similar in habitat to the remnant site, by La Trobe University, Department of Environment, Land, Water and Planning (DELWP) Port Phillip and Australian Native Orchid Society (ANOS) Victoria.

Figure 1. Sunshine Diuris, *Diurus fragrantissima*, growing *in situ* in grassland near Melbourne. Photos: Royal Botanic Gardens Board

Figure 2. Yellow flags mark emergent wild plants at Sunshine for monitoring in July 2020. Photo: E. James

The first experimentally-designed introduction included 600 individuals planted out between September 2004 and April 2005 (Smith 2006). However long term demographic monitoring of this and later introductions revealed that plants have not recruited or survived in sufficient numbers to be considered a self-sustaining population (Duncan and Moloney, 2018). The current project aims to address significant knowledge gaps to improve conservation outcomes for this species.

Genetic studies

In the case of *D. fragrantissima,* the *ex situ* collections comprise the majority of the species' genepool. The high risk of losing existing wild plants and the low success rate of reintroductions (Duncan and Moloney, 2018) means that maintaining the genetic diversity *ex situ* in conjunction with suitable mycorrhizal fungi is vital to enable the future provision of genetically diverse seedlings for *in situ* conservation.

Previous studies reported high levels of genetic variation in *ex situ* collections of *D. fragrantissima* and its differentiation from related species (*e.g.*, Smith *et al.* 2007). The RBGV *ex situ* collection comprises plants of different ages including some plants thought to have been brought into cultivation directly from the wild, and plants produced from hand pollination of *ex situ* or wild plants in the past two decades. As highly sensitive genomic methods have become available to assess individuals, it is timely to take stock of the genetic characteristics of *D. fragrantissima*, both *in situ* and *ex situ*, to ensure that seedlings produced for future reintroductions are genetically representative of the species as a whole.

For this study, we collected leaf samples in July 2020 from 13 wild plants and 20 reintroduced plants at the remnant wild site, and 184 *ex situ* plants from the RBGV collection including mature plants and seedlings. Each sample was genotyped using DarTseq (Diversity Arrays Technology, Canberra) a reduced representation DNA sequencing method that enables a comparison of genetic diversity among individuals.

Our results and where to from here

The purpose of our study was to quantify and compare the genetic variation in both *in situ* and *ex situ* plants, and to identify any genetic outliers that would suggest caution in their use for breeding purposes or reintroductions. In our first round of sampling, we found one main cluster with representatives from all sample sources and conclude that those individuals can be used for artificial pollinations (Figure 3). However, some *ex situ* plants formed either a separate cluster (samples, right hand side) or showed some differentiation from the main cluster (samples, top). At this stage, we are taking a conservative approach and will confirm the identity of these individuals and the level of inbreeding before they are used in crosses. Outbreeding depression is uncommon in Orchidaceae and is likely to be of less concern for *D. fragrantissima* than inbreeding, particularly as *ex situ* and reintroduced plants are likely to be derived from the remnant population (*Editor's note: Outbreeding depression is when fitness is reduced as a result of breeding between different groups e.g., populations, subspecies)*. Individuals that do not cluster with the majority of samples may be reflecting different breeding histories and/or the effects of cultivation conditions. For example, germplasm from extinct populations could make up part of the genetic heritage of outlier *ex situ* samples. As our intention is to maximise the genetic diversity used in seedling production, these apparent outliers may well be a valuable resource.

We would like to expand sampling in coming years to include plants from the introduction site and unsampled wild plants to see a more complete picture of the genetic diversity in *D. fragrantissima*. However, results so far provide guidance for artificial crosses to maintain an *ex situ* population for future introductions

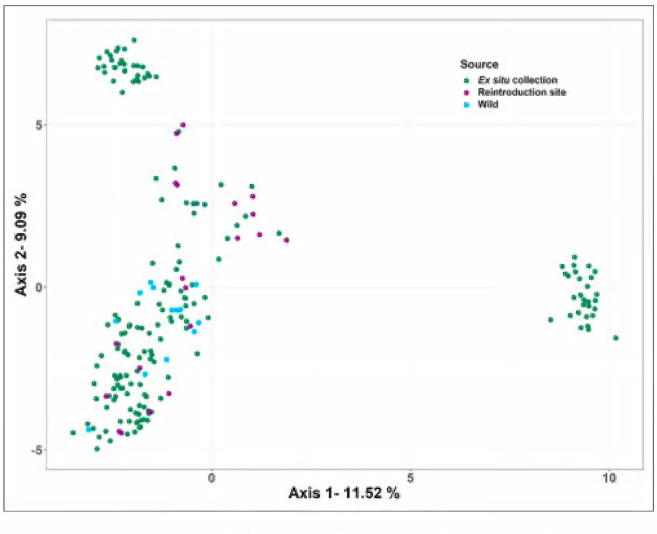

Figure 3. Genetic results from DarTseq (Principal Coordinates Analysis). Most samples form a loose cluster irrespective of whether they are original wild plants, reintroduced plants or part of the RBGV *ex situ* collection. However, some ex situ plants grouped separately and warrant further investigation prior to their reintroduction and/or use in the breeding program.

that incorporates the genetic variation present overall. Ongoing genetic management of *D. fragrantissima* will be facilitated by maintaining pedigrees of all crosses in future years to minimise the risk of inbreeding or unintentional selection by environmental conditions under cultivation.

Acknowledgements

Thanks to John Bradbury and DELWP for providing access to the wild population in 2020, the *Diuris fragrantissima* Recovery Team, and members of ANOS, RBGV nursery staff and our many volunteers who continue to contribute to the conservation challenges of the Sunshine Diuris.

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Buttercup Doubletail orchids (*Diuris aequalis*) thriving after the 2019–20 bushfires

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Background

The Endangered Buttercup Doubletail orchid (*Diuris aequalis*, Figure 1) is a pure gold-coloured terrestrial orchid occurring in high altitude areas of the Central and Southern Tablelands of NSW from Oberon to Braidwood. Despite being widespread and having several populations, prior to 2020 all but a handful of the populations had less than 20 individuals. Threats to the species include habitat loss for development and agriculture, damage from roadworks and grazing by native and domestic herbivores.

Under the NSW Saving our Species (SoS) program, populations of Buttercup Doubletail orchids have been monitored annually to better understand fluctuations in numbers due to yearly variation in climatic conditions.

The stronghold of the Buttercup Doubletail orchid is within Kanangra Boyd National Park (KBNP), near Oberon. In 2019, the numbers were estimated at around 75 individuals inside permanent monitoring cages and approximately 200 plants across the total survey area. That same area was surveyed in spring 2020 following the Green Wattle Creek bushfire, which burnt most of KBNP ten months earlier. There was a rare opportunity to monitor the species' response to fire.

Figure 1. Buttercup Doubletail orchid. Photo: Laura Canackle, DPIE

Grazing pressure from native herbivores (primarily wallabies and wombats) is high within the park, and in early 2019 permanent cages were installed around individual plants, as well as a 20 m x 20 m fenced exclosure, to exclude herbivores and monitor emergence and flowering of the population.

2020: An excellent year for orchids

With widespread regular rain since March, 2020 was shaping up to be a profuse orchid season throughout south east NSW, including across the range of Buttercup Doubletail orchids. In fact, the 2020 annual rainfall at nearby Jenolan Caves was the second highest on record (1691 mm), whereas the same station in 2019 recorded the second *lowest* rainfall (469 mm) on record. Additionally, in 2019 Oberon recorded its highest maximum mean temperature on record.

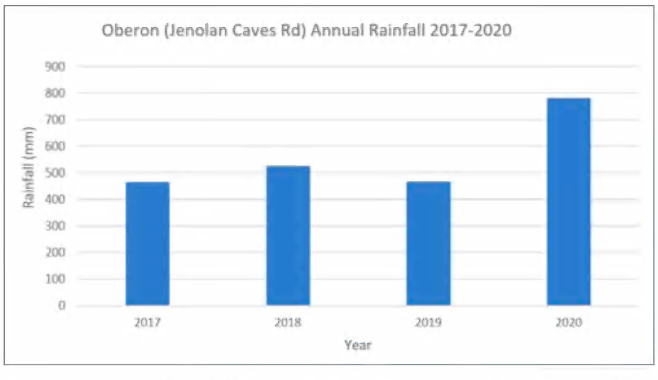

Figure 2. Annual rainfall recorded at Oberon (Jenolan Caves Rd) station (Bureau of Meteorology 2021).

Spring survey and monitoring methods

In June 2020, following the bushfires, all individual cages were found to be collapsed in place and were able to be reinstalled with the numbered plant tags still identifiable, which enabled the annual monitoring program to be undertaken as usual.

Monitoring and survey was undertaken in October-November 2020 and all flowering plants within the cages and exclosure were counted.

Additionally, new areas within KBNP were also surveyed to locate the extent of the population within the park. Survey was undertaken on foot by random meander in two-person teams over large areas of suitable habitat and each flowering plant was recorded on GPS.

Figure 3. One of the numbered tags installed prior to the fires were still identifiable despite being burnt. Photo: Laura Canackle, DPIE

Results

In KBNP in 2020, 154 flowering plants were recorded in the cages and exclosure. This compares with 75 plants in 2019 (Figure 4).

Interestingly, over 100 plants were recorded within the exclosure (Figure 5), double what had been recorded the previous year.

Across KBNP, over 1,000 additional plants which were recorded during the extensive 2-day survey, including several sites where they had not been recorded, and this has extended the known distribution of the species within the park by 400% (from ~100ha to ~500ha).

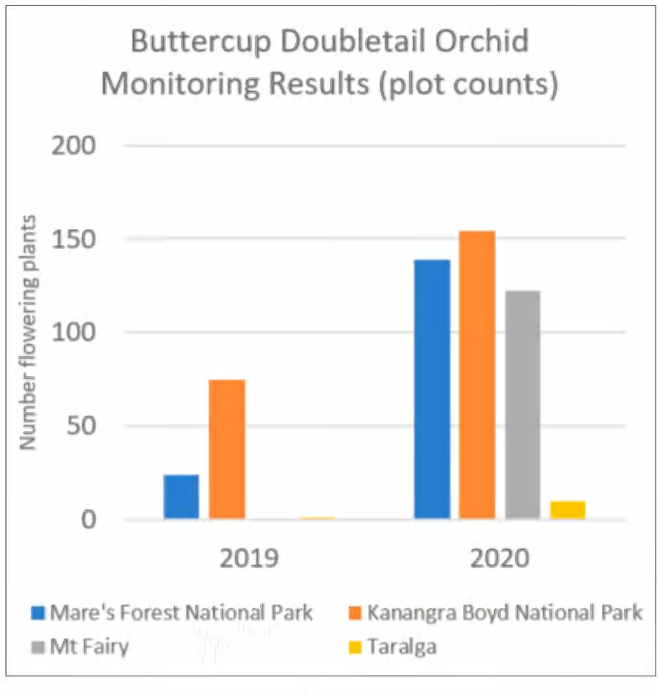

Figure 4. Monitoring results of four buttercup doubletail populations between 2019 and 2020.

Other populations

Due to the optimal rainfall in 2020, a letterbox drop was coordinated to engage with landholders with nearby suitable habitat. As a result, four new populations were recorded on private property, including one of over 250 plants at Mount Fairy near Braidwood.

Several factors may have contributed to the increase in Buttercup Doubletail orchids in 2020. The bushfires in KBNP may have benefited the species by reducing the number of native herbivores and competition for water and light from other vegetation. An increase in numbers was also seen across other populations, suggesting that the increased rainfall was a significant factor in flowering response.

Since its installation in 2019, the herbivore exclosure has protected an increasing density of orchids, demonstrating the impact of macropod grazing on this species.

Given that 2021 is also shaping up to be an abundant year for orchids, and KBNP still possesses such a large area of unsurveyed suitable habitat for Buttercup Doubletail orchids, it is hoped that this coming spring will uncover further populations.

Figure 5. Buttercup Doubletail orchids thriving within the exclosure in 2020 following bushfires in Kanangra Boyd National Park. Photo: Laura Canackle, DPIE

Acknowledgements

Thanks to NSW National Parks and Wildlife Service, Kanangra Area especially John Good, Phoebe Reeves and Ben Correy for project support and local knowledge. Buttercup Doubletail survey support legends Alicia Palmer, Trent Forge, Michaela Jones, Alex Pike and Matt Kent were also of great assistance to me in the field.

Reference

Climate data online, Bureau of Meteorology, Copyright Commonwealth of Australia, 2021.

Genomic approaches for species delimitation in threatened species

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Summary

A study published earlier this year by Wagner *et al*. draws attention to the potential utility of genomic analysis in species delimitation, and threatened species conservation. Specifically, Wagner *et al.* (2021) demonstrate the insight that genomic data can bring to resolving relationships among individual plants, populations and species. Wagner *et al.* (2021) worked on the *Corybas aconitiflorus* complex – a group of small, inconspicuous orchids, including one threatened species. While Wagner *et al.* (2021) concluded that more work is needed to delimit species in the *Corybas aconitiflorus* complex, their study provides guidance (and comfort) to botanists who have had difficulty differentiating these *Corybas* species in the field. In addition, the results provide direction for conservation – through the identification of genetically distinct populations. The approach described by Wagner *et al.* (2021) could usefully be applied to other species (not just orchids) affected by taxonomic uncertainty. The need for collaboration in conservation has never been greater – and this includes translating results of studies such as these into conservation action.

Introduction

Background

Orchids in the genus *Corybas* are often inconspicuous in the field, because they are small – consisting of a little hooded flower over a single leaf. They do, however, form colonies. Three species in the genus, *Corybas aconitiflorus*, *C. barbarae* and *C. dowlingii,* are morphologically very similar (Figure 1) and have overlapping geographic distributions, posing difficulties for field identification. Earlier this year, Wagner *et al.* (2021) published a study entitled "Conservation in the face of hybridisation: genome-wide study to evaluate taxonomic delimitation and conservation status of a threatened orchid species". The aims of the work included clarification of taxonomic concepts within the *Corybas aconitiflorus* complex, which contains *C. dowlingii* and *C. barbarae. Corybas dowlingii* is listed as Endangered on the *Biodiversity Conservation Act 2016* (NSW) and Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).

Previous research on this *Corybas* complex (prior to Wagner *et al.* 2021) showed that comparing a small number of specific DNA sequences (or 'markers') was not informative for distinguishing (delimiting) taxa. This research used five plastid and three nuclear markers (eight markers in total), which were not informative for delimitation of species within this complex (Clements *et al.* 2002, Lyon 2014). In the past, molecular studies only used a small number of markers which were often not able to discriminate well between closely related species. Since the advent of high-throughput DNA sequencing, it has become routine to use tens and even hundreds of markers.

Why is this study important? Conservation, species delimitation and hybrids

Biodiversity conservation has historically focused on species; however, how species are conceptualised and delimitated are topics which continue to be debated. A practical approach to this issue has been put forward by De Queiroz (2007). He suggests that: (1) there is general agreement in the concept of a species as a "separately evolving metapopulation lineage", and (2) other properties, including morphological differences, genetic/genomic differences, reproductive incompatibility, monophyly, and niche differences, can be treated as secondary (cf. necessary) lines of evidence for species delimitation (Figure 2; please see Box 1 for a glossary of common genomics terms). De Queiroz (2007) recommends that one property should not be prioritised over another; instead, that a taxon having more properties (or strands of evidence) could be considered to have more corroboration of its delimitation. Genomic analysis is becoming increasingly available, providing another useful strand of evidence.

Hybridisation can occur when species are in this grey zone. There is growing recognition of the conservation value of hybrids, as they can potentially be ecologically beneficial, including through their genetics (*e.g.*, increasing genetic diversity), functional role in an ecosystem, species fitness and more (Jackiw *et al.* 2015). Moreover, hybridisation has played an important role in the evolution and diversification of plants. Conversely, hybrids can have negative impacts on biodiversity, especially if they pose a risk to their parental species (*e.g.*, via genetic swamping), or other native species (Rhymer and Simberloff 1996). Jackiw *et al.* (2015) discuss the issue of conservation of hybrids more thoroughly than is possible here. Hybridisation and introgression are frequently observed in orchids. In the *Corybas aconitiflorus* complex, Wagner *et al.* (2021) found evidence for occasional interspecific hybridisation – evidence that the species boundaries are blurred. Indeed, recent research has demonstrated that some species we recognise today are actually ancient hybrids, for example some *Thelymitra* species (Nauheimer *et al.* 2018) are the product of hybridisation which occurred thousands of years ago.

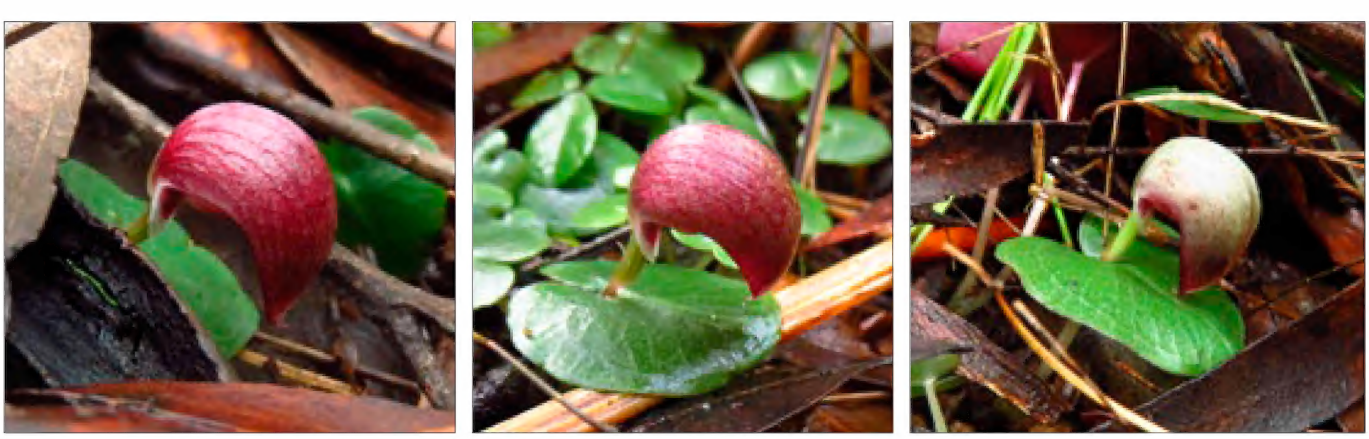

Figure 1. *Corybas* species at Alum Mountain, ranging from entirely red to mostly white. Photos: Heidi Zimmer

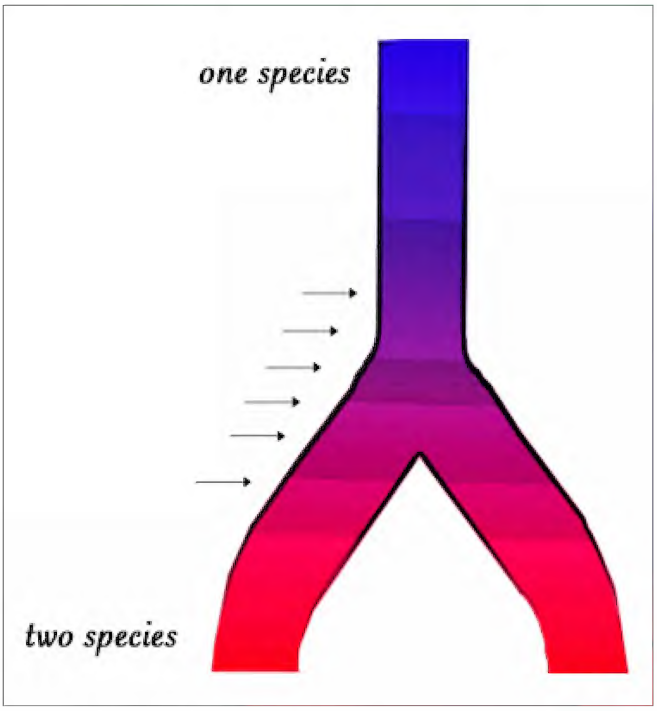

Figure 2. Adapted from de Queiroz (2007). Theoretical diagram showing separation of a single species to become two species. Horizontal lines indicate times at which the species are characterised by different properties – that they become, for example, morphologically or ecologically or genetically distinct. Above the first arrow there is general agreement that there is one species, below the last arrow there is general agreement there are two species, in between the arrows there is disagreement as to whether there is one species or two.

Effective conservation of biodiversity – and efficient use of conservation resources – is reliant upon accurate delimitation of the species – or other unit – which is being conserved. Coates *et al.* (2018) highlight it is also possible for us to conserve not only species, but subspecies, populations, 'evolutionary significant units' or 'management units'. Genomic data give us unprecedented insight into relationships among and within these groups. Coates *et al.* (2018) provide a useful and thorough discussion of these issues, especially with respect to conservation implications. The potential for genomic analysis to inform conservation is so great that conservation practitioners should not be deterred by the (sometimes impenetrable) vocabulary used by geneticists. Box 1 defines some commonly used terms and gives some examples; other terms and concepts are described within the text.

Methods

Next generation sequencing and statistical analysis

Wagner et al. (2021) used double digest restriction site associated DNA sequencing (ddRADseq), which is a NGS method. Briefly, RADseq is a 'reduced representation library sequencing' method, involving randomly sampling from across the genome, in this case, by selecting fragments of a certain size. These fragments are subjected to high-throughput sequencing. Wagner *et al.* (2021) provide detail on these methods.

Wagner *et al.* (2021) used DNA samples taken from 70 individual plants within the *C. aconitiflorus* complex from across eastern Australia. Resulting data (thousands of markers) were subject to: phylogenomic analysis (reconstruction of evolutionary relationships using genome data), network analysis (to identify relationships resulting from hybridisation), genetic structure analysis (to investigate the distribution of genetic variants among populations and group similar ones), co-ancestry analysis (further explores genetic structure) and hybridisation detection (testing for hybridisation or introgression at a species or population level).

Results

Wagner *et al.* (2021) found that the monophyly of the three species *C. aconitiflorus, C. barbarae* and *C. dowlingii* was not supported. Instead, they identified evidence of interspecific hybridisation and introgression within the *C. aconitiflorus* complex. There were several samples of *C. aconitiflorus* and *C. barbarae* that showed close genetic affinities to *C. dowlingii*. In particular, the *C. dowlingii* samples from Lake Cathie showed close affinity with the *C. barbarae* from Lord Howe Island. The multiple, different genetic analyses of Wagner *et al.* (2021) essentially each identified the same genetic groupings: usually specimens of the same species, from the same geographic location (or population), grouped together – but not always.

In addition, Wagner *et al.* (2021) found that hybridisation, though infrequent, is happening among individuals in this complex through weak pre-zygotic (pre-fertilisation) and post-zygotic (post-fertilisation) barriers. The detection of genetically admixed individuals indicates plant-pollinator relationships within the *C. aconitiflorus* complex are less specific and allow for occasional cross pollination.

Wagner *et al.* (2021) emphasise that further population genomic study is required for species delimitation – they do not propose any taxonomic change with regard to the species in the *C. aconitiflorus* complex. This further research will include specimens of *C. dowlingii* from the location from which it was described (the type site) (M. Clements, pers. comm.).

Discussion

This study provides another strand of evidence (genomic evidence), in addition to observations of morphology and flowering times, that the boundaries among species in the *C. aconitiflorus* complex are blurred. However, Wagner *et al.* (2021) also found that populations, including populations of *C. dowlingii,* were genetically distinct. Wagner *et al.* (2021) recommend an extended population genomics study to assess species delimitation, and hybridisation and introgression in more depth –

they do not seek taxonomic change. However, the study was informative for conservation, as outlined below.

Further study required

Wagner *et al.* (2021) emphasised the need for extended population genomic study – suggesting ddRADseq or custom target sequence capture (TSC) analyses. Target sequence capture is another next generation sequencing method. Similar to RADseq, it samples across the genome, but distinct from RADseq, it is not random. Instead, TSC can focus on regions of the genome which are likely to be informative (vary among groups of interest) and has the benefit of being repeatable. Target sequence capture can be used both for phylogenetics and population genomics. While single nucleotide polymorphism (SNP) data and genotyping by sequencing with DArTseq are the current standard for population genomics, they have the disadvantage that it cannot be exactly repeated (and they are not so useful for phylogenetics as they focus on active regions of the genome only). It appears that the future for orchid sequencing may be TSC. According to the IUCN Specialist Group for Molecular Identification of Orchids, TSC is the preferred tool for building genetic reference datasets for orchid identification, including from degraded material (K. Nargar, pers. comm.).

Application of genetic/genomic data for conservation of *Corybas* and other Australian orchids

Wagner *et al.* (2021) point to two key considerations for conservation in the *Corybas aconitiflorus* complex: conserving genetic diversity and maintaining evolutionary potential. Specifically, Wagner *et al.* (2021, p. 166) state "In the case of *C. dowlingii*, the conservation of an existing rare genotype needs to be balanced against maintenance of the evolutionary potential, which lies in hybridisation. Given that the two widespread species within the *C. aconitiflorus* complex, *C. aconitiflorus* and *C. barbarae*, occur in sympatry over a large distributional range, maintenance of this evolutionary potential can be safeguarded while at the same time accommodating the protection of *C. dowlingii* from potential genetic swamping." The conclusions of Wagner *et al.* (2021) can be compared with two other recent studies on the genetics/genomics and conservation of Australian orchids.

Box 1: Genomics terms explained

- **Bait kits:** Are used to retrieve specific DNA fragments (or RNA species), which are informative about evolutionary relatonships. This includes genes which have descended from a common species, but now differ now different (descendent) species. These genes are known as orthologs.
- **Genomics:** Genomic analyses consider organism's DNA (all its genes) in its entirety – its genome. Genetic analysis, in contrast, focuses on one-to-a-few specific genes. For reference, the orchid *Phaelaenopsis equistris* has approximately 30,000 protein coding genes (Cai *et al.* 2015).
- **Genetic swamping:** When the local genotype is overwhelmed (and sometimes replaced) by a hybrid genotype.
- **Genotyping by sequencing (GBS):** A method which identifies SNPs, which are then used to identify differences among individuals and populations.
- **Introgression:** Hybridisation and repeated back crossing.
- **Hybridisation:** "the interbreeding of individuals from genetically distinct populations" (Allendorf *et al.* 2001).
- **Next generation sequencing** (NGS): Also referred to as high-throughput sequencing. NGS describes the range of new technologies which sequence DNA and RNA quickly and cheaply, compared to older methods (*e.g.*, Sanger sequencing). To illustrate, Sanger sequencing reads one DNA sequence at a time, whereas NGS allows sequencing of hundreds to thousands of sequences in parallel. Because of the rapid speed of processing and lower costs, NGS allows interrogation across the whole genome.
- **Marker:** DNA sequence. In plants, these markers can be within the DNA which is stored in the chloroplast (plastid markers) or nucleus (nuclear markers). A common nuclear marker is internal transcribed spacer (ITS) DNA.
- **Microsatellites:** Also known as single sequence repeats (SSR). They are another type of marker used in genetic analysis, like a SNP.
- **Monophyly:** Is when all individuals in the group (*e.g.*, species) have a common ancestor, and that the group contains all descendants of this common ancestor (cf. polyphyly: the group does not have a single common ancestor). Monophyly is one property which is used to delimit species (see de Querioz 2007).
- **Pre-zygotic barriers:** Barriers that occur before fertilisation *e.g.*, specific plant-pollinator relationships, different flowering times.
- **Post-zygotic barriers:** Barriers that occur after fertilisation *e.g.*, that the hybrid is unviable.
- **Single nucleotide polymorphism (SNP):** a nucleotide which varies between sampled individuals.
- **Species delimitation:** the process of determining boundaries between species.

Ahrens *et al.* (2017) describe a study of four closely related *Diuris* species, including two threatened species (*D. basaltica,* listed on the EPBC Act; *D. gregaria* listed on the *Flora and Fauna Guarantee Act 1998* (Vic). These species had overlapping distributions and similar morphological characteristics. Morphometric analysis confirmed morphological characters were poorly differentiated among the species. Genotyping by sequencing (GBS) revealed evidence of a high level of gene flow and a low level of inbreeding in the complex, but that populations of *D. gregaria* showed some differentiation/isolation (~4% of total variation in the GBS datasets). The conservation management implications of these findings are discussed in detail by Aherns *et al.* (2017), but to summarise, they conclude that it is best to conserve all four species as one unit, with the primary consideration of maximising evolutionary potential.

Swarts *et al.* (2014) similarly tackled the problem of species delimitation, focusing on the genus *Caladenia*, and in particular 25 species within the *Caladenia* 'reticulata' complex (including several threatened species). They used microsatellites for population genetic analysis, in addition to one nuclear and three plastid markers for phylogenetic analysis, along with pollination specificity tests. Microsatellite data confirmed little genetic variation among populations within Victoria, but showed evidence of isolation of Victorian versus South Australian populations. The phylogenetic analysis showed little-to-no species-level resolution in the reticulata complex, even among species with different pollinators. Swarts *et al.* (2014) emphasise the value of a combined approach, using not only morphology and genetics, but also pollinators: *Caladenia hastata* and *C. richardsiorum* are both listed as threatened species, were not differentiated in the phylogenetic analysis, but did have specific pollinators. Swartz *et al.* (2014) recommend that conservation programs, instead of focusing on "narrow-range endemic geographic islands", should focus on preserving evolutionary processes and adaptive ability by conserving populations across the geographic and morphological range of the species.

Conclusion

Wagner *et al.* (2021), Ahrens *et al.* (2017) and Swarts *et al.* (2014) each describe the challenges of conserving morphologically indistinct species, and use genomic data to gain powerful insight into evolutionary relationships and conservation units. These studies together suggest that it is not uncommon for orchids to diverge morphologically before they diverge genetically … and have a distinct pollinator/chemical signal before they are morphologically or genetically distinct – in line with de Queiroz (2007) (also Figure 2). In terms of conservation recommendations, the three studies are similar, calling for the consideration of complexes as a whole – to maintain evolutionary potential – but ensuring conservation of distinct (genetic or pollinator-defined) units.

The work needed to come to grips with the genomics vocabulary, and gain a basic understanding of genomics techniques, is a small price to pay for the potential benefits genomic data can bring to conservation. The application of genetic/genomic data, especially in identification and delimitation of species and/or genetically distinct populations, to inform conservation action, is an issue at the forefront of conservation research, management and policy in 2021. This is illustrated by a slew of recent publications, for example:

- Rossetto *et al.* (2021) argue in support for the cost effectiveness of incorporating genomic information conservation management planning for threatened plants.
- Melville *et al.* (2021) focus on the risk of extinction of species which have not yet been described ("Without taxonomic research, the conservation and management of unrecognised species will not proceed", page 5), presenting a framework to prioritise description of threatened species.
- Cook *et al.* (2021) highlight the need to improve knowledge exchange between evolutionary biologists and conservation practitioners.

Acknowledgements

Thank you to Zoe Knapp, Katharina Nargar, Anthony Whalen and Judy West for their thoughtful feedback on earlier drafts of this manuscript.

Editor's note

Heidi Zimmer is a research scientist at the Centre for Australian National Biodiversity Research (a joint venture between CSIRO and Parks Australia). Heidi has recently joined the orchid research program, where she actively collaborates with Katharina Nargar, Mark Clements and Lalita Simpson, including on genetic and genomic studies of orchids.

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Second year post-fire monitoring of the Endangered Superb Midge Orchid (*Genoplesium superbum*) in South-eastern NSW

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Introduction

The Superb Midge Orchid (*Genoplesium superbum*) is a small (up to 30 cm tall) native Australian ground orchid that spends a part of the year underground as a dormant tuber. The orchid is present above ground from January to June each year and flowers between summer and autumn. In summer a single green stem grows from the tuber and eventually produces a cluster of tiny magenta flowers with long hairy labella (Figure 1(a)). Once pollinated, the orchid produces oval seed capsules, which then split open to release the seed. Not all individuals flower each year, nor do they all flower at the same time within a local population. The Superb Midge Orchid is listed as Endangered in NSW (*Biodiversity Conservation Act 2016*) and there are only around 200 known individuals across five populations on the NSW Southern Tablelands.

The conservation of the Superb Midge Orchid is compromised by several threats including small population size, low pollination rates, loss of pollinators, drought and decreasing rainfall, damage from roadworks or vehicles, herbivory, and trampling. Under the Saving our Species (SoS) program, actions have been undertaken in the last five years to protect the species, including an annual population census, demographic studies, caging of plants, and seed collection for seedbanking.

Methods

The Saving our Species program monitors five known populations of the Superb Midge Orchid. Two populations are in Morton National Park (RS, TR), which was severely burnt in the Currowan bushfire in February 2020 (Figure 2), two populations are on roadsides (CF, OF), and one population is on private land (HM, Figure 3). In 2021, populations were surveyed on multiple occasions between January and June to collect population and demographic data. All individuals were pinned with identification tags to aid future surveys and to collect multi-year demographic data. Population pollination rate was calculated as the proportion of plants that were pollinated at each population. Individual pollination rate was calculated as the proportion of flowers on a plant that were pollinated. Pollinated flowers can be identified by their swollen ovaries, which develop into seed capsules, unpollinated flowers do not develop seed capsules (Figure 1(b) and (c)).

Figure 1. Superb Midge Orchids at different development stages. (a) in full flower, (b) pollinated flowers with developing seed capsules, and (c) unpollinated flowers. Photos: Erika Roper, DPIE

Results and Discussion

Population size

In 2021, 100 new plants were located during systematic surveys of the five populations monitored by Saving our Species (SoS), bringing the total number of known plants up to 201 individuals (Table 1). Given the cryptic nature of the Superb Midge Orchid and its habitat preferences it is possible that more plants may exist on rock shelves in Morton National Park and in other locations on private property. At Morton National Park large numbers of Pink Flannel Flowers (*Actinotus forsythii*) obscured much of the site and made it difficult to locate some plants pinned in 2020 (Figure 2). Repeated surveys over multiple years are required to determine an exact population size.

Table 1. Number of Superb Midge Orchids pinned at each population in 2020 and 2021.

Population	Burnt	2020	2021
RS	y	23	66
TR	y	29	35
CF	n	27	33
OE	n	26	35
HM	n	13	21
Total		118*	190*

*additional orchids were observed at some sites but were not pinned and are not included in this summary

Flowering rate

Mean flowering rate was similar at burnt and unburnt populations (Table 2), suggesting that all populations received the same cues to trigger flowering (*i.e.*, high summer rainfall events) (Canackle *et al.* 2020).

Figure 2. Burnt habitat at Morton National Park (RS), with regrowth and Pink Flannel Flowers. Photo: Erika Roper, DPIE

Figure 3. Unburnt habitat on private property (HM) in intact woodland. Photo: Erika Roper, DPIE

Herbivory rate

Burnt populations showed no evidence of herbivory, likely due to a loss of herbivores in the fire and a delay in recolonisation by herbivore species (macropods and wombats). Of the unburnt populations only one experienced herbivory, with 43.75% of flowering plants being eaten by a wombat (Table 2).

Pollination rate

Pollination rates differed between burnt and unburnt populations (Table 2). Pollination rate was three times higher in unburnt population than burnt population, at both a population level and an individual level. The pollinators of the Superb Midge Orchid are currently unknown, but other *Genoplesium* species are thought to be pollinated by Chloropidae flies (Bower *et al.* 2015), which were not observed in these populations. This suggests a temporary loss of pollinators at burnt populations followed by a failure of those pollinators to return, possibly due to loss of understory vegetation in the fire. Long-term monitoring of these burnt populations is critical to determine the recovery of pollinators and their services.

Conclusions

The apparent loss of pollinators in burnt populations is a major threat to the species and may result in decreased recruitment in the near future. Plans for the 2022 season include caging all individuals in the population that experiences herbivory, monitoring herbivores and pollinators using remote camera traps, an investigation into pollination, and a survey of additional areas.

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Acknowledgements

Thanks to Rob Armstrong for laying the groundwork for the project in previous years and collection of 2020 data, Laura Canackle, Roger Farrow, Mary Appleby, and Jude Nettleingham for assistance with surveys, and landowners who have assisted in the protection of the species and permitted annual monitoring. Thanks also to Bronwyn Ayre and Damon Oliver for providing feedback and comments.

Table 2. Population, flowering, and pollination data for burnt and unburnt populations of the Superb Midge Orchid in south-eastern NSW.

	Plants present in 2021	Total flowering	Total pollinated	Total eaten	Population flowering rate (mean ± SE)	Population pollination rate (mean ± SE)	Individual pollination rate (no. individuals) (mean ± SE)	Population herbivory rate (mean ± SE)
Burnt	101	66	8	0	65.43% ±0.28%	12.34% ±0.71%	17.32% ± 6.21%	0.00% ± 0.00%
Unburnt	89	52	21	7	60.61% ±8.18%	42.08% ±11.19%	51.40% ± 24.58%	43.75%* ± 14.58%

* the mean herbivory rate for the unburnt populations was 14.58%, however as two of the three populations had no herbivory, we have chosen to report the herbivory rate of the one population that did experience herbivory.

Do all fire ephemerals warrant listing under threatened species legislation?

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Vegetation surveys are commonly undertaken to list or monitor plant species within a nominated area, and outcomes can be particularly dynamic in many environments. For most plants, the presence of above-ground components is ordinarily sufficient to enact an identification, albeit within the caveat of seasonality for those taxa where the presence of fertile material is needed to confirm identity. Terrestrial orchids, for example, can rarely be confirmed without the seasonal emergence of flowering stems from underground tubers, or fruiting bodies may be required to distinguish between closely related species of Cyperaceae or Chenopodiaceae. There is also a whole suite of taxa ('disturbance specialists') which may only appear after some form of significant disturbance event (*e.g.*, forest thinning, flood, fire) but will persist often for many years or decades in the above-ground flora. Representatives from the widespread Fabaceae and Rutaceae families are good examples of this life-strategy.

But what about those taxa that emerge following a fire event and rapidly mature, set seed and die within a short time period? These are commonly referred to as 'fire ephemerals', and although such taxa may be abundant during certain stages of a fire cycle, their persistence in an area may well only be within the seed bank for many decades. Bond and van Wilgen (1996) define fire ephemeral species as those that appear soon after fire, have relatively short life spans, are usually dead before the next fire, and rely on fire for regeneration. This life strategy can complicate assessments of conservation status when there are few records due to poor timing of surveys relative to fire events.

Fire ephemerals and conservation assessments

Within the IUCN guidelines for the listing of threatened taxa (IUCN 2019), key drivers for qualification are Area of Occupancy (AOO), Extent of Occurrence (EOO), population size and decline. These attributes are invariably drawn from herbarium collections and verified observation records, which provide an overview of how widespread or restricted a taxon may be.

Clearly, such databases are heavily dependent on the amount of effort that has gone into searching for a specific taxon, and this is especially so for those that are rarely seen due to seasonality or ephemerality. Fire ephemeral species will, by definition, only be detectable shortly after a fire event: searches in appropriate habitat at all other times will invariably result in no plants being seen. So, to what extent has this life form strategy been incorporated into conservation assessments of legally threatened and other taxa? What influence have taxa with few records due to fire ephemerality had on current threatened species listings? Are all such taxa really threatened?

Fire ephemeral species are represented within the Apiaceae [Araliaceae], Malvaceae [Sterculiaceae], Poaceae and Solanaceae families, and all of the Gyrostemonaceae (Baker *et al.* 2004). Other families also support fire ephemerals, but these are often less well known (*e.g.* Polygonaceae, Hunter *et al.* 1998; Prober *et al.* 2007; Geraniaceae, Kubiak 2009). New fire ephemeral species continue to be described following discoveries in long unburnt post-fire landscapes (*e.g.*, Perkins 2017; Perkins and Dilly 2017), and some species known from few populations at the time of their naming have subsequently been found to be abundant after fire events (*e.g.*, Mulcahy *et al.* 2021).

Listed vs unlisted fire ephemerals

To illustrate the difficulty in application of threatened status to fire ephemerals it is useful to consider examples of listed and unlisted taxa that have emerged following recent wildfire seasons. Most of these have been drawn from the Greater Blue Mountains World Heritage Area of NSW, where fire events over the last 10 years have promoted germination and led to increased observations. Several of these taxa also occur in other states, often abundantly so (Table 1).

Table 1. Listed and unlisted fire ephemerals discussed in text. Records are based on herbarium (AVH) and observational (Bionet) databases, cleaned of duplicates.

Family	Taxon	Current status		Ex-NSW	Records
		NSW BC Act[1]	Cwlth EPBC Act[2]		
Apiaceae	*Actinotus forsythii*	-	-	Vic	86
Euphorbiaceae	*Monotaxis macrophylla*	End.	-	Qld	137
Gyrostemonaceae	*Gyrostemon australasicus*	-	-	Vic WA SA	6
	Gyrostemon thesioides	End.	-	Vic WA SA Tas	7
Malvaceae	*Androcalva procumbens*	Vul.	Vul.	-	188
	Androcalva rosea	End.	End.	-	65
	Commersonia rugosa	-	-	-	49

[1] *NSW Biodiversity Conservation Act 2016*
[2] *Environment Protection and Biodiversity Conservation Act 1999*

Malvaceae, Euphorbiaceae and Apiaceae

In northern Wollemi National Park (NP) in central eastern NSW, new populations of the Endangered *Androcalva rosea* (Malvaceae) and *Monotaxis macrophylla* (Euphorbiaceae) (Fig. 1) were initially reported in Bell and Holzinger (2015) following post-fire surveys. Neither of these species had ever been recorded in this part of that NP previously, and for *Androcalva rosea* this represented a 30 km extension of range from the type locality. Both species were present in their thousands and were the dominant ground cover at that time. Further populations of both species, again in their thousands, have also been located following the most recent fire events in other parts of Wollemi and Goulburn River NPs, and near Yengo NP. New populations of *Monotaxis* have also been reported elsewhere in large numbers post-fire (*e.g.* Miles 2019; Saunders 2020). Both of these species are clearly secure in these lands with no real threats operating, and there seems little reason to retain them on threatened species listings. A third species, *Androcalva procumbens* (Malvaceae), was also located in its hundreds (possibly thousands) on burnt rocky ridgelines in Goulburn River NP as part of recent post-fire inspections in May 2021 (Fig. 2). Just two of countless burnt ridgelines were inspected during this brief helicopter-based survey, suggesting that many more populations of this vulnerable species were likely across this reserve.

In contrast, recent fire events in the Blue Mountains NP and other areas have promoted large populations of the rarely seen but unlisted wiry herb *Actinotus forsythii* (Loots 2021; Noble 2021) (Fig. 3, 4). Despite these impressive displays, flora databases (Bionet and AVH) have only 86 unique observations or collections of this species between 1902 and 2021, a period of nearly 120 years. Similarly, the unlisted *Commersonia rugosa* (Fig. 5) has been observed at several locations in Goulburn River NP and environs after recent fires, yet this species has only 49 unique records between 1893 and 2011. By comparison, the threatened *Monotaxis macrophylla* has 137 unique records, *Androcalva procumbens* 188 records (both over a similar 120-year period), and *Androcalva rosea* 65 records over 25 years (from 1996). On a comparative reporting basis, the question may be asked: Why are *Monotaxis macrophylla, Androcalva procumbens* and *Androcalva rosea* considered threatened species, while the less commonly observed

Figure 1. *Monotaxis macrophylla* (yellow-green) dominating post-fire landscapes in northern Wollemi NP, October 2020. Photos: Stephen Bell

Actinotus forsythii and *Commersonia rugosa* are not? All occur in similar well protected landscapes with few threats, and all undergo often dramatic increases in above ground representation after fire events, but quickly die out. Part of the answer may be explained by the realisation that increased reporting of records generally occurs *after* a taxon is listed as threatened. However, irrespective of that all these species follow similar boom or bust life strategies: should all be considered threatened, or none of them?

Figure 2. Post-fire ephemeral *Androcalva procumbens* colonising rocky open ridge lands in Goulburn River NP, May 2021. Photo: Stephen Bell

Figure 3. *Actinotus forsythii*: rarely seen fire ephemeral but not listed as threatened. Photo: Gavin Phillips

Figure 4. *Actinotus forsythii* carpeting the ground at the Budawangs. Photo: Gavin Phillips

Figure 5. *Commersonia rugosa*: rarely seen fire ephemeral but not listed as threatened. Photo: Stephen Bell

Gyrostemonaceae

Another useful comparison can be made within the Gyrostemonaceae family. Two species of *Gyrostemon* are currently known in New South Wales: *G. australasicus* from far south-western parts of the State and *G. thesioides* from the greater Sydney area. Both appear to occupy restricted ranges based on few records (six unique NSW records for G. *australasicus*, the most recent in 2008; and seven for *G. thesioides*, the most recent in 2004), yet only one (*G. thesioides*) is currently listed as threatened. In relation to threats, none are mentioned within notes for any observations or collections of *G. thesioides*, yet for *G. australasicus* trampling by goats is highlighted for one record from 1977. Comments linked to observations for both species confirm their fire ephemerality, and in all other aspects database records of these two species are comparable. The final determination to list *G. thesioides* as Endangered in 1998 specifies lack of recent records (>30 years) as a key factor but implies continuing decline in habitat quality, although this is not supported by evidence.

Historical records (1910 to 1967) of *Gyrostemon thesioides* at the time of its listing all occurred between Ingleburn and Douglas Park in largely urbanised inner western Sydney, including one record on the edge of the Holsworthy Military Area. There are no more recent records of this species from these locations, although it may persist still in the seed banks there. Since listing in 1998, two new records of this species 70 km apart were made in 2001 from Blue Mountains NP and in 2004 from southern Wollemi NP, both following wildfires that passed through these areas. These observations were both incidental and un-targeted finds yet given the wide expanse of conserved lands of similar habitats between the two, considerably more populations of *Gyrostemon thesioides* may occur in conserved lands all around Greater Sydney. By contrast, all records for *Gyrostemon australasicus* (1977 to 2008) fall within unreserved lands north-east of Mildura, where this species is legally

unprotected but considered rare in NSW (Porteners *et al.* 1997). The questions then arise whether *Gyrostemon thesioides* should remain listed as Endangered given secure potential habitat across large parts of the Greater Blue Mountains World Heritage Area, should *Gyrostemon australasicum* be nominated for listing given few records in unsecured habitat, or should neither species be listed?

A suggested strategy

All of these examples suggest that plant taxa, such as fire ephemerals, that are rarely seen will not always require listing as threatened. It can be difficult to determine whether rarely seen species are threatened without a solid understanding of their ecology, but this needs careful consideration when any assessments of conservation status are made. To avert the possible misdirection of conservation funding away from taxa that really are threatened, a simple four step process might be employed:

1. **Understand life-history**: this may seem obvious but gaining knowledge on what drives recruitment and persistence in a taxon is imperative. Assessments of conservation significance cannot be confidently made when there are knowledge gaps in basic ecology, and this includes such things as what promotes germination, what constrains growth and persistence following germination, and the time period over which individuals are reproductively mature and can contribute to replenishment of the seed bank.
2. **Document habitat requirements:** what are the preferred habitats and environmental conditions necessary to maintain a taxon within the local flora? If fire is needed, how often and how intense should they be without compromising persistence of a taxon in an area?
3. **Assess land tenure**: where are most known records and likely habitat located, and more specifically are they evident within secure conservation lands? If much of the range and potential habitat falls within national park estate, then it might be expected that the target taxon is also secure, irrespective of limited records.
4. **Consider listing (or delisting)**: if a taxon is shown to be relatively short-lived, quick to mature, dependent on fire to break seed dormancy, and occurs predominantly in secure conservation tenure with few active and real threats, then it may be unnecessary to list as threatened (despite a lack of recent observations). Taxa seen only occasionally over long periods of time should be considered as 'rarely seen', not threatened. Existing listings of fire ephemeral taxa might also be regularly reassessed in the light of new data. The Endangered *Androcalva rosea* for example is now far more abundant and widespread than previously known at the time of its listing in 2004, with extensive new populations located in recent years after wildfire events, some in areas that have not seen fire for up to 70 years. This species could now be considered one of least concern under IUCN criteria.

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Myrtle Rust Sentinel Project at Auckland Botanic Gardens, New Zealand

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Introduction

A sentinel survey is when a group of plants outside their natural range, *e.g.*, in a botanic garden, are regularly monitored for pests, diseases and pathogens that might be new to that species. This acts as an early warning system for biosecurity agencies where pests or pathogens are not yet in their country but are present overseas on the species of interest.

The International Plant Sentinel Network (IPSN) has been developed by Botanic Gardens Conservation International (BGCI) to facilitate collaboration between botanic gardens and arboreta, and plant health organisations and scientists (IPSN, 2014). Auckland Botanic Gardens (ABG) is one of the 67 members of the IPSN.

Botanic gardens have key roles in education, conservation and research. Botanic gardens hold documented living collections which have incredibly valuable information to support research and conservation. Databases of botanic garden collections are useful tools to plan sentinel surveys. Species outside of their natural ranges and gardens with known host plants in the range of specific pests and pathogens can be identified. Botanic gardens are therefore well placed to support biosecurity initiatives such as surveillance of new pests or pathogens.

Myrtle rust (*Austropuccinia psidii*) is a fungal disease that affects plants in the Myrtaceae family (MPI, 2020). Plants in this family include *Acca sellowiana* (Feijoa), *Leptospermum scoparium* (Mānuka), *Psidium cattleianum* (Guava), *Metrosideros excelsa* (Pōhutukawa) and *Syzygium smithii* (Lilly pilly). Myrtle rust infects leaves, flowers, fruits and stems of plants, reducing their vigour and reproductive output and can eventually lead to plant death.

The myrtle rust sentinel survey has run at ABG since 2014, initially with the aim of detecting the arrival of myrtle rust in NZ and subsequent to its arrival detecting preferred hosts and documenting impacts. Plants were initially selected for the sentinel survey based on their geographical location, evenly spaced across the site with initial detection in mind. The species contained a range of native and non-native species, as well as being informed by species highly susceptible in Australia. It served this purpose until myrtle rust arrived in New Zealand in 2017 when the information that researchers and organisations required changed to understanding host preferences and susceptibility, rather than just presence information. Myrtle rust was first detected at ABG in July 2018.

Sentinel Survey 2014–2017

The aim of this survey was to detect myrtle rust as soon as possible in any incursion at ABG. Myrtle rust was expected to arrive naturally from Australia (where it is an invasive organism originating from Chile). ABG wanted to assist the Ministry of Primary Industries (MPI) in the early detection of this organism to increase the chances of eradication being a possible goal.

The garden was divided into 16 zones to ensure wide coverage of the site. In each zone, at least one plant in the Myrtaceae family was selected for monthly checking for symptoms of myrtle rust. Plants were selected for their accessibility, known susceptibility in Australia, economic importance and rarity (Table 1). An additional three areas held multiple individuals of susceptible species (the nursery, *Leptospermum* collection and *Eucalyptus* on the lawn) and in these areas many plants were inspected.

At each selected tree species, if there was more than one plant of this species at each zone, one was selected to look at carefully. All other Myrtaceae in the vicinity were briefly scanned for myrtle rust as well. For larger groups of Myrtaceae, including the area Nursery, *Leptospermum* or *Eucalyptus*, 25% of the plants in that area were scanned for myrtle rust. All accessible sides of the tree were checked. Flowers, fruit and new leaf growth were visually inspected for yellow pustules. Plants were never touched to avoid potential spread of myrtle rust. On the field data sheet, presence/absence was recorded.

Table 1. List of plant species included in sentinel survey from 2014–2017.

Name	Country of origin
Acca sellowiana 'Triumph'	Garden origin
Agonis flexuosa	W. Australia
Backhousia citriodora	Australia: Queensland
Callistemon citrinus 'Anzac White'	Garden origin
Callistemon viminalis 'Hannah Ray'	Garden origin
Eucalyptus cinerea	Australia
Eucalyptus spp	Australia
Kunzea ericoides	New Zealand
Kunzea sinclairii	New Zealand
Leptospermum cultivars	Garden origin
Leptospermum scoparium	New Zealand
Lophostemon confertus	Australia
Melaleuca alternifolia	Australia: NSW, Queensland
Metrosideros bartlettii	New Zealand
Metrosideros excelsa 'Vibrance'	Garden origin
Metrosideros nervulosa	Lord Howe Island
Psidium guajava	C. & S. America
Psidium littorale	E. & S. Brazil to NE. Uruguay
Syzygium jambos	Himalaya to W. Malesia
Syzygium luehmannii	New Guinea, Australia

Sentinel survey 2018–2021

Incursion of myrtle rust detected on mainland New Zealand in 2017 changed the purpose of the sentinel survey from an early detection/warning system, to gathering information about host preferences and susceptibility. Our focus shifted to which native plants, threatened plants and popular garden plants (Table 2) that we recommend, get myrtle rust and if they get it, how severe the impacts are on them through time. Plants were added or removed based on changes with plantings in the gardens. For example, many *Lophomyrtus bullata* died from heavy thrip damage rather than myrtle rust infections and therefore few individuals remained and these were different to the plants that were previously checked in the first sentinel surveillance programme (Fig. 1). Plants in both surveys are indicated in table 2 with an asterisk.

Figure 1. Bec surveying myrtle rust in the garden. Photo: Emma Bodley

Table 2. List of plant species in sentinel survey from 2018–2021. An asterisk (*) indicates plants that were also in the 2014–2017 sentinel survey.

Name	Country of origin
Acca sellowiana 'Triumph'*	Garden origin
Austromyrtus dulcis	E. Australia
Backhousia citriodora	Australia: Queensland
Callistemom vimalis 'Little John'	Garden origin
Callistemon 'Great Balls of Fire'	Garden origin
Callistemon viminalis 'Hannah Ray'	Garden origin
Kunzea amathicola	New Zealand
Kunzea ericoides	New Zealand
Kunzea linearis	New Zealand
Kunzea robusta	New Zealand
Kunzea salterae	New Zealand
Kunzea serotina	New Zealand
Kunzea sinclairii	New Zealand
Kunzea tenuicaulis	New Zealand
Kunzea toelkenii	New Zealand
Kunzea triregensis	New Zealand
Leptospermum cultivars*	Garden origin
Leptospermum scoparium	New Zealand
Lophomyrtus bullata	New Zealand
Lophomyrtus obcordata	New Zealand
*Lophostemon confertus**	Australia
Luma apiculata	Argentina, Chile
*Melaleuca alternifolia**	Australia: NSW, Queensland
*Metrosideros bartlettii**	New Zealand
Metrosideros carminea	New Zealand
Metrosideros diffusa	New Zealand
Metrosideros excelsa 'Awhitu'	Garden origin
Metrosideros excelsa 'Shakespear'	Garden origin
Metrosideros excelsa 'Te Kaha'	Garden origin
Metrosideros excelsa 'Titirangi'	Garden origin
Metrosideros excelsa 'Vibrance'*	Garden origin
Metrosideros excelsa 'Waimatuka'	Garden origin
Metrosideros excelsa x *collina*	Garden origin
Metrosideros fulgens	New Zealand
Metrosideros perforata	New Zealand
Metrosideros robusta x *excelsa*	Garden origin

Detections and control

Over the seven years of survey data seven species and 14 cultivars have been detected with myrtle rust at ABG (Table 3) however only two of these were on the sentinel survey including *Syzygium jambos* and *Austromyrtus dulcis* (both detected in 2021). *Syzygium jambos* (Fig. 2) is the only plant that has been removed as a sentinel plant due to its high level of infection (in 2021), four years after the incursion of myrtle rust in New Zealand and three years after the first incursion at the Auckland Botanic Gardens. Not all plants infected with myrtle rust at ABG are completely removed, so that we get an understanding of the impact myrtle rust has on plant health and host preferences. Some infected plants are removed (Table 3) because they have no conservation value or horticultural merit. Some infected plants have been kept and infected material removed *e.g.*, isolated symptomatic branches.

Figure 2. *Syzygium jambos* heavily infected with myrtle rust. Photo: Emma Bodley

Figure 3. *Lophomyrtus bullata* infected with myrtle rust. Photo: Emma Bodley

Table 3. Detections of myrtle rust at Auckland Botanic Gardens on sentinel and non-sentinel survey plants, as well as how myrtle rust was managed in each individual case.

Date	Name	Sentinel plant	Control measurement
28/06/2018	*Lophomyrtus* x *ralphii* 'Red Dragon'	No	Removed
13/03/2019	*Lophomyrtus bullata*	No	Removed
28/03/2019	*Lophomyrtus* cultivars* (Fig. 3)	No	Removed
4/04/2019	*Lophomyrtus* cultivars*	No	Removed
6/05/2019	*Metrosideros excelsa* 'Vibrance'	No	Pruned
17/07/2019	*Metrosideros excelsa*	No	Pruned
4/02/2020	*Myrtus communis*	No	Removed
19/01/2021	*Syzygium jambos*	Yes	Removed
22/02/2021	*Metrosideros carminea*	No	Monitoring
22/02/2021	*Metrosideros excelsa* 'Vibrance' (Fig. 4)	No	Pruned
26/02/2021	*Myrtus communis*	No	Removed
9/04/2021	*Austromyrtus dulcis*	Yes	Monitoring
27/05/2021	*Metrosideros excelsa*	No	Removed

**Lophomyrtus* in these detections included *Lophomyrtus bullata*, *L.* 'Black Beauty', *L.* 'Kathryn', *L.* 'Lilliput', *L.* 'Little Star', *L.* 'Multicolor', *L. obcordata*, *L.* 'Pinkadoo', *L.* 'Pixie', *L.* 'Plum Duff', *L.* 'Purpurea', *L.* 'Red Dragon', *L.* 'Rose', *L.* 'Traversii' and *L.* 'Variegata'.

How we manage Myrtaceae

Our general principals and aims for managing Myrtaceae on a day-to-day basis at ABG include:

- Minimise the use of fungicides by staff and reduce inoculum at ABG site outside nursery.

Figure 4. Myrtle rust on *Metrosideros excelsa* 'Vibrance'. Photo: Emma Bodley

- Document impacts of myrtle rust on native, rare and exotic edible and amenity plants.
- Grow rare plants such as *Metrosideros bartlettii* (rātā moehau) to protect them from extinction by holding insurance plants and cross-pollinating flowers for seed production (Stanley and Bodley, 2020).
- Support research into myrtle rust through observations, provision of plant material etc. (Beresford *et al.*, 2020).
- Participate in research and policy forums to stay up-to-date and contribute our observations and promote the use of the ABG site and staff for research capacity.

In the Garden we manage plants by:

- Removing dead and very sick/dying plants and smaller plants that are producing lots of inoculum.
- Discussing options for trees that may be highly affected and releasing inoculum (which are costly to remove and may not be budgeted for).
- Monitoring plants less visibly affected to document impacts of myrtle rust and inform research.
- Removing infected branches or parts of plants to research effectiveness of this technique.
- Avoiding pruning of any Myrtaceae that would result in a flush of growth in autumn, the peak time for myrtle rust activity.

The ABG nursery grows 60,000 native plants, primarily Myrtaceae, for revegetation projects throughout Auckland in parks. Nursery biosecurity is a critical component of our work to prevent the spread of pests and pathogens to wild locations (Stanley and Dymond, 2020). In the nursery we follow the New Zealand Plant Propagators Inc. (NZPPI) protocols in terms of propagation, fungicide regimes and distribution policies to minimise the risk of myrtle rust spread to wild environments. We also minimise the time Myrtaceae plants are held in the nursery to minimise the amount of fungicide applications, *e.g.* once revegetation is dispatched the only reason to apply fungicide is for ABG plants. Myrtaceae are planted as early in the planting season as possible to reduce numbers in the nursery. Placement of plants in the nursery is to ensure the leaves of plants dry out *e.g.*, the windiest place for better airflow.

Benefits of sentinel projects

One of the aspects of being part of the IPSN is it builds the network of expert contacts locally, and worldwide, which is needed to strengthen our collective biosecurity systems. Out of being part of the network has come collaborations such as the B3 trail which allows visitors to self-guide a trail at ABG of 12 future threats to New Zealand's biosecurity, participation in a worldwide project on rose pests and pathogens, and joint conference presentations.

Conclusion

The sentinel survey has contributed several new species to the growing list of myrtle rust plant hosts for New Zealand, a valuable contribution to the biosecurity and research community. Some myrtle rust detections were not on sentinel plants such as *Myrtus communis* and *Lophomyrtus* x *ralphii* 'Red Dragon', and therefore this survey is not used as a full surveillance tool, but rather an indicator of presence and susceptibility. Although the survey is a long-term project, it is regularly reviewed for its purpose and what information we are capturing.

Figure 5. Students from a local high school investigating myrtle rust and other plant pathogens at the gardens. Photo: Rebecca Stanley

The sentinel project has also been a useful tool for teaching professionals and students about myrtle rust and other plant pathogens (Fig. 5). We can use our plant collections to teach people Myrtaceae identification skills, as well as identifying myrtle rust.

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News from the Australian Seed Bank Partnership

A national partnership approach to bushfire recovery through seed conservation for Project Phoenix

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The unprecedented 2019–20 Australian fires burnt a wide variety of vegetation types including peatlands, rainforests, and alpine habitats, with many of the most adversely impacted areas having never experienced fires before or, if so, not with such intensity. The long-term impact of fire on these sensitive areas is only now becoming better understood, with further work required for years to come. The task of assessing and supporting conservation outcomes for affected species in these habitats is critical and has been a major focus for the Australian Seed Bank Partnership (the Partnership) over the last 18 months.

As part of the national response to the bushfires, the Australian Government provided funding for Project Phoenix, a Greening Australia-led program to build and secure native seed and plant supply for landscape restoration, recovery and resilience in bushfire-affected areas. Supported by funding from Project Phoenix, the Partnership worked across all six states and the Australian Capital Territory to deliver various on-ground conservation activities including rapid flora assessments, germplasm collection, and germination trials for bushfire affected species.

Project outcomes

An initial phase in this work involved an extensive analysis of species information to determine high priority conservation actions. This information was considered in conjunction with bushfire impact information produced by the Department of Agriculture, Water and the Environment and the Threatened Species Bushfire Recovery Expert Panel. The analysis enabled the Partnership to prioritise species at both the national and regional levels and target their efforts to secure germplasm and post-bushfire response data.

Once target species were identified, the Partnership completed a total of 120 collections of 103 taxa providing a long-term *ex situ* insurance policy for these priority flora. These included 29 collections of 28 previously unbanked taxa, as well as 91 collections of 75 previously banked taxa to increase genetic diversity and bolster the size of current conservation collections. Seed was sourced from species across 44 plant families, providing increased taxonomic representation in *ex situ* seed banks with collections available for future use in restoration and research.

The Partnership completed 53 germination trials of 42 taxa to develop species-specific germination protocols and to test existing collections for their viability following long-term storage *ex situ*. These protocols better inform our understanding and approach to post-bushfire recovery, as seedlings can be more easily germinated for restoration, and seed of threatened species is not wasted through repeat trials or by the application of ineffective treatment methods. Similarly, the data gained from the 192 rapid flora assessments for 90 taxa under this project can be utilised in concert with other bushfire response studies to inform and adapt management decisions in the event of future bushfire events.

Figure 1. Collections of *Sphenotoma drummondii* were made in the Stirling Range National Park, WA. Photo: Andrew Crawford

Partner project stories from around Australia

- Bushfire recovery work on Kangaroo Island provided the South Australian Seed Conservation Centre the opportunity to work with botanists, landowners, and volunteers on threatened species. Their efforts helped rediscover species known only from historic records, as well as contributing six new species records for the Island including *Chenopodium erosum*. This strengthened collaboration with the Kangaroo Island community has bolstered enthusiasm in the Island's threatened flora, promising further collaboration and discoveries in years to come.
- The Duck's Head Wasp Orchid *(Chiloglottis anaticeps)* is an endangered ground orchid known from populations of a few hundred individuals in the New England Tableland of NSW. In January 2021, a team from The Australian PlantBank assessed the populations to find that while sites suffered light understorey burns, they were still intact. At one location the population was estimated to be more than 50,000 plants. These findings allowed PlantBank staff to attain conservation collections and plan for management actions in following seasons.
- The Threatened Eastern Stirling Range Montane Heath and Thicket ecological communities in WA are home to a range of threatened plant species, with many represented by a small number of mature plants in isolated pockets of unburnt vegetation. The Department of Biodiversity, Conservation and Attractions actively monitors the status of these communities, and the information compiled from this monitoring enabled the Western Australian Seed Centre, Kensington to secure collections from nine threatened species during this project. Germinants from some of these collections will be established in seed orchards to increase seed numbers, facilitating future *in situ* recovery actions for these species.
- The entire Victorian population of the Woolly-Bear Wattle (*Acacia lucasii*) was severely burnt in the 2019–20 bushfires. Prior to the fires, population estimates on the Nunniong Plateau were limited to a few hundred plants. Site assessments made by the Victorian Conservation Seedbank in March 2021 found that, despite harsh, hot fires, this species was recruiting in abundance, with thousands of seedlings observed to carpet the otherwise bare ground.
- Project Phoenix enabled staff of the National Seed Bank at the Australian National Botanic Gardens to visit previously inaccessible sites in Kosciuszko National Park and collect taxa such as the small perennial herb *Galium roddii*. Understanding how these taxa respond to fire has provided the Partnership with an indication of the resilience of some habitats in the face of more frequent fires.
- The Tasmanian Seed Conservation Centre undertook rapid flora assessments of the delicate bittercress *(Cardamine tryssa)*, finding that the plant fares reasonably well through a fire and may in fact benefit from this disturbance. Assessments discovered four additional populations of the species around the Great Lake area, bringing the known populations in Tasmania to 15. From the largest of these populations 45,000 seeds were collected and these will contribute to a better understanding of this previously overlooked herb.

Future bushfire work

While some of the species targeted through this project appear to have responded well to the fires, it is critical that monitoring and collection of these species continues for several years post-fire. Although recruitment for some species appears to be significant in the first year following a major fire event, it is possible that subsequent threats such as grazing pressure, floods and disease, may act to reduce the survival of individuals beyond the first-year post-fire.

Analysis of the seed collections and information made under Project Phoenix will continue in 2021–22 to enable further prioritisation of flora conservation and to better inform preparedness and response to future bushfire events. In conjunction with Greening Australia's forthcoming *Strategy for the Australian Seed Sector*, we hope that these analyses prove useful in understanding the interactions and alignment that may result between the conservation and restoration sectors. Working collectively, we can better manage landscape restoration, support biodiversity and mitigate threats.

In the year ahead the Partnership will continue to work in bushfire affected areas as part of the Rare Bloom Project, and the recently announced Island, Alps and Forests Project. For more about the Partnership's projects please visit: seedpartnership.org.au/initiatives/

Banking on seeds for bushfire recovery (part 1)

The Australian Seed Bank Partnership received a grant through the Australian Government's *Wildlife and Habitat Bushfire Recovery Program* to fund their '*Banking on seeds for bushfire recovery*' project. The project aimed to limit the decline of 25 species from fire affected areas in the ACT, NSW, SA, Vic and WA. Through this two-part case study series, we'd like to introduce you to some of the species in this project.

Case Study 1

The Dorrigo Daisy Bush (*Olearia flocktoniae*) is a small, short lived shrub found only on the Dorrigo Plateau, in north-east NSW. This Endangered plant grows mainly on roadside verges placing it at risk from vehicle damage and local extinction. Staff from the Australian Botanic Gardens, Mount Annan secured diverse seed collections for this species, including from new habitats discovered after the 2019–20 bushfires. Plant occurrences, health and abundance records were also shared with project and land managers to educate about the ecology of the species, especially regarding its disturbance regimes and abundance.

Image: Gavin Phillips RBGDT

Case Study 2

Forrester's Bottlebrush (*Callistemon forresterae*) is a striking-coloured shrub listed as Vulnerable in Victoria. This species is found only in rocky sites along the Upper Genoa River which flows from southern New South Wales into eastern Victoria. Staff at the Royal Botanic Gardens Victoria conducted germination testing on this species and determined the optimal temperature range for *Callistemon forresterae* germination. From this study a number of seedlings of this species were produced. These will be planted by the Friends of Mallacoota in the local area to increase wild populations.

Image: Neville Walsh

Case Study 3

Stylidium tepperianum is a tiny trigger plant which grows only on Kangaroo Island off the coast of South Australia. Classified in the state as Rare this species can be found in coastal woodland and heath habitat. In 2020–21, the South Australian Seed Conservation Centre assessed *Stylidium tepperianum* recovery in one- and two-year old fire scars on Kangaroo Island. They also collected and banked 4,600 seeds from a population in the Seal Bay region. In 2021–22, other populations on the western side of the Island will be targeted for further assessment and seed collection.

Image: South Australian Seed Conservation Centre

Download the full fact sheets on these species, developed in collaboration with the ANPC, a:
https://www.seedpartnership.org.au/initiatives/bushfire-recovery/banking-seeds-for-bushfire-recovery/

Workshop and publications reports

Orchid conservation in Australia and across the globe

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Orchids are a fascinating group of species. Whether people are drawn to their beautiful flowers, their unique relationships with insects and fungi, or their rarity, they attract attention for many reasons.

The conservation of orchids was showcased in an online Symposium run by the ANPC in June 2021. The Orchid Conservation Symposium brought together eighteen speakers from five countries to highlight their latest research. These global experts took us on a journey from fire affected bushland in southern Australia and gorges in the Kimberley, to flower markets in Asia and the Drakensberg Mountains of South Africa.

Dr Amy Hinsley's presentation 'From Flowers to Icecream' shone light on the illegal orchid trade, particularly in Asia. Back in Australia, threats to orchids were outlined by Dr Jenna Wraith. To prevent extinction of threatened orchids, translocations can be undertaken, and Dr Noushka Reiter, Dr Belinda Davis and Dr Gunter Fischer spoke about their work in translocating threatened species in Victoria, Western Australia and Hong Kong respectively. Len Carrigan gave a volunteer's eye view of assisting with translocations.

How orchids are faring after the recent fires was discussed by Dr Bronwyn Ayre and Dr Jenny Guerin, and they also spoke about the need to develop long-term projects for fire-affected orchids. It is encouraging to see some orchids emerging in the blackened landscapes.

Pollination of orchids is fascinating, and Professors Steve Johnson and Ron Peakall spoke about the unique adaptations of orchids to attract particular pollinators in Africa and Australia respectively. We heard about pollination of the Warty Hammer Orchid (*Drakaea livida*) from Dr Alyssa Weinstein, and of the Glossy-leaved Hammer Orchid (*Drakaea elastica*) from Dr Myles Menz. Both species use sexual deception to trick male wasps into pollination. Tobias Hayashi explained how male fungus gnats pollinate many *Pterostylis* species (greenhoods), and the importance of research on the identification and taxonomy of the gnats. Dr Russell Barrett also spoke about identification and taxonomy – he has spent many years finding and naming new plant species in the Kimberley, and showed some beautiful photos of orchids he has discovered, some deep in gorges or locations only accessible by helicopter.

Speakers and ANPC staff on day 1 of the online Orchid Conservation Symposium.

Dr Lucy Commander introducing Dr Ryan Philips.

As well as pollinators, orchids have a special relationship with mycorrhizal fungi, which are required for germination of orchid seed. Professor Celeste Linde updated us on orchid-fungi interactions, and highlighted the diversity of fungi which form associations with orchids. Marc Freestone showed that through his research on fungi, he was able to germinate endangered *Prasophyllum* species (Leek orchids), allowing the first successful propagation of this genus.

New technology is helping conservation, and Richard Dimon showed camera traps that he and his team have developed to study pollinators. Dr Myles Menz has been studying pollinators using tethered flight mills and radio-telemetry.

The need for multi-disciplinary research teams was highlighted by Professor Rod Peakall in particular, who showed that for orchids that release chemicals to attract pollinators, chemistry, pollination and conservation

are all connected – requiring chemists, entomologists, geneticists, taxonomists, and mycologists to work together to conserve orchids. Many talks showed the importance of research to inform management, and Dr Ryan Phillips outlined the importance of translating theoretical advances in orchid biology to conservation practice.

New ways of communicating have led to new markets for illegal orchids, as sellers can reach buyers through the internet. On the flip side, the potential of using social media for conservation education and to attract volunteers was discussed.

The next generation of orchid conservationists were included in the Symposium, with presentations from Marc Freestone, Alyssa Weinstein and Tobias Hayashi on their PhD research.

575 people from 37 countries registered for the Symposium, making it likely to be the largest event that the ANPC has organised. Attendees were from volunteer groups, universities, government departments, botanic gardens and industry. Our audience found the talks highly engaging, asking over 70 questions on both days of the Symposium. A follow up survey found that over 96% of attendees rated the presentations as excellent or very good, and several commented that they would use the information learned in their work or when volunteering. Selected talks are available on the ANPC's YouTube Channel for those who missed the event https://www.youtube.com/c/AnpcAsnAu/featured.

The ANPC would like to acknowledge and thank the Australian Government's Wildlife and Habitat Bushfire Recovery Program Funding for funding both this Symposium and the larger project it is part of, which aims to prevent extinction of 14 nationally threatened orchid species extensively affected by the 2019-20 bushfires in the Australian Alps (NSW), East Gippsland (VIC) and at Kangaroo Island (SA). For more information, see https://www.anpc.asn.au/projects/preventing-extinction-in-bushfire-affected-orchids/. We would also like to thank our project partners, in particular La Trobe University, the Royal Botanic Gardens Victoria and Botanic Gardens of South Australia and the project leads, Ryan Philips, Noushka Reiter and Dan Duval.

The climate is ripe for seed knowledge – Florabank Guidelines Released

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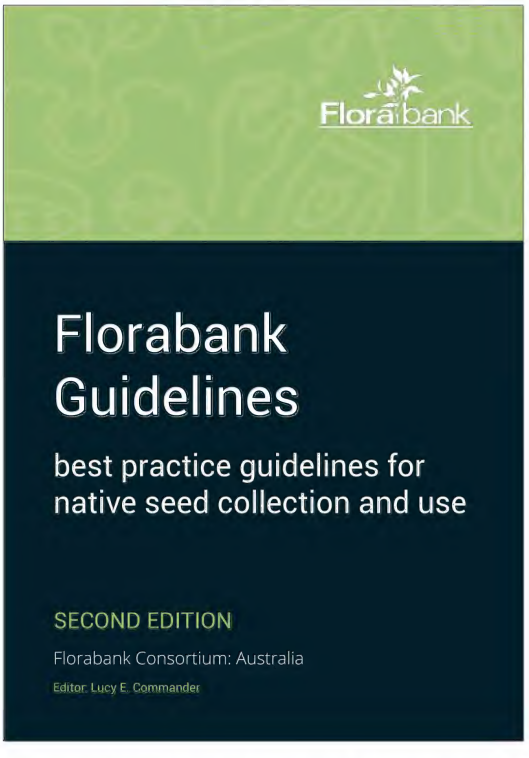
[2]The University of Western Australia

Everyone that works with native seed across Australia – from policy makers to planters and large-scale restoration practitioners – can now access the latest knowledge from across the seed sector. The Florabank Guidelines, originally published two decades ago as a user-friendly guide, have been updated to include 20 years of research and practical experience.

The guidelines were updated as part of the '*Healthy Seeds Project*' funded by the NSW Environmental Trust and managed by the Australian Network for Plant Conservation (ANPC) Inc, led by ANPC Project Manager Dr Lucy Commander. The Guidelines are publicly available from the revamped Florabank website (www.florabank.org.au/guidelines). Florabank is a consortium of partners from the ANPC, CSIRO, Australian National Botanic Gardens and Greening Australia.

This document represents the latest best practice guidelines for native seed collection and use in Australia. Over 40 national and international experts including practitioners, agency staff and researchers generously gave their time and expertise for the much-needed update.



The second edition of the Florabank Guidelines provides best practice guidelines for native seed collection and use.

The Florabank Guidelines contain modules which follow the seed supply chain from sourcing through to final use. The revision also includes additional information on working with Indigenous Australians, approvals, record keeping, and tips for seed purchasers.

Improving our knowledge about how to collect and use native seeds is critical for everyone who is restoring land so this release is timely for plant conservation and ecological restoration in Australia.

Everyone involved with native seed is encouraged to download and read the updated guidelines especially if you work in policy, tree planting, research, restoration, collecting, bush regeneration, landcare, mine rehabilitation or conservation.

The Florabank Guidelines will help all those involved with native seeds. Photos: M. Driver, L. Commander, P. Gibson-Roy.

Launch of 'Plant Germplasm Conservation in Australia' Third Edition

AMELIA MARTYN YENSON
Australian Network for Plant Conservation

Germplasm Guidelines launched during Australasian Seed Science Conference

The Germplasm Guidelines were recently launched by Prof. Tim Entwisle, Director and Chief Executive of the Royal Botanic Gardens Victoria, on 7th September, during the Australasian Seed Science Conference.

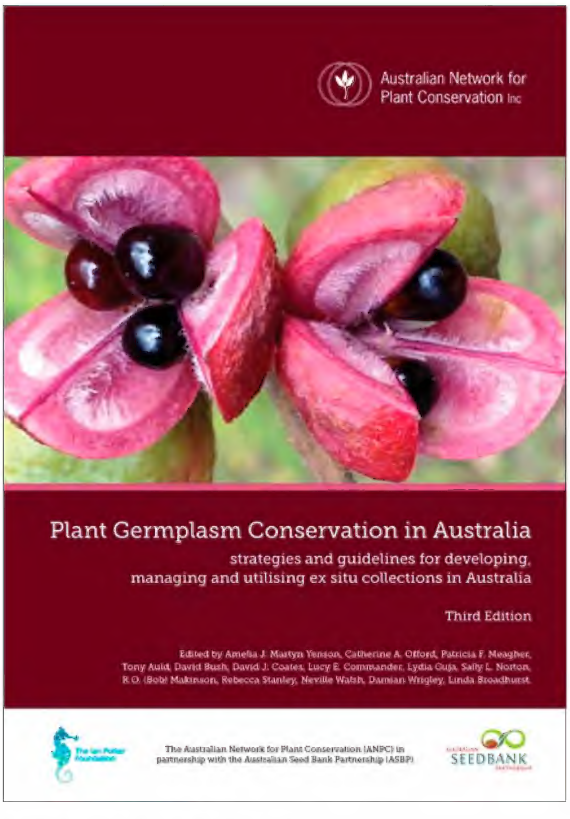
Prof. Entwisle described the Guidelines as 'timely, necessary and perfectly pitched'.

You can enjoy watching the launch video on the ANPC YouTube channel, thanks to the Australian Seed Bank Partnership (https://youtu.be/Gi_EqF-tdGI).

This joint publication by the ANPC and the Australian Seed Bank Partnership is the third edition of this practical, science-based handbook for *ex situ* (off site) conservation of plant material (germplasm). The revision was generously funded by The Ian Potter Foundation. Production of the third edition was a collaborative and inclusive project, with 78 contributors from seed banks, botanic gardens, organisations including CSIRO and universities throughout Australia with additional contributors from New Zealand, the US and the UK.

This abridged excerpt from Chapter 1 (Introduction) describes the intent of germplasm conservation:

"The ultimate objective of *ex situ* germplasm conservation is to support the survival or restoration and continued natural evolution of species in self-sustaining populations in the wild… The Australian Network for Plant Conservation, from its founding in 1991, has strongly advocated the integration of *in situ* and *ex situ* techniques – that is, making *ex situ* actions serve *in situ* conservation of plant biodiversity to the maximum extent possible,



Germplasm Guidelines cover.

while recognising that *ex situ* germplasm maintenance has a variety of purposes…*Ex situ* conservation is important because *in situ* management may not be sufficient to prevent a decline in threatened plant species, particularly under climate change or with novel disease threats such as Myrtle Rust."

New and updated chapters

The third edition has seven additional chapters, reflecting advances in our understanding of:

- The genetics of acquiring and maintaining *ex situ* collections.
- The identification of non-orthodox species that require storage methods other than conventional seed banking.
- The role of the nursery in *ex situ* conservation.
- *Ex situ* conservation of orchid mycorrhizae and legume rhizobia.
- *Ex situ* conservation of underrepresented groups such as carnivorous and parasitic species, and storage of non-seed material such as spores and pollen.

Introductory chapters on planning and collecting germplasm are complemented by chapters on risk management and preparation for crises, as well as the maintenance and utilisation of germplasm collections and associated data and images. Existing chapters on seed and vegetative material collection, seed banking, germination and dormancy, tissue culture, cryopreservation and living collections have been comprehensively updated. These chapters give practitioners, volunteers and students summaries of the latest techniques, literature and procedures for optimising germplasm storage and use.

Throughout the Germplasm Guidelines, practitioners have shared their knowledge and experiences through 50 case studies. Some have been recently published in long form in Australasian Plant Conservation and are available for Open Access on the project website: https://www.anpc.asn.au/germplasm-guidelines-review/ex-situ-conservation-case-studies/

Germplasm Guidelines electronic version

The Germplasm Guidelines are now available for free download at: https://www.anpc.asn.au/plant-germplasm/

Hard copies are also available from the ANPC Office, using the link above.

You can access the Plant Treasures video series through the playlist 'Plant Germplasm Conservation in Australia' on our YouTube channel (https://www.youtube.com/c/AnpcAsnAu/playlists)

Workshops and fact sheets

The final six months of the Germplasm Guidelines revision will include production of fact sheets, preparation of training materials for workshops and conferences and production of the final Plant Treasures video series.

Stay tuned for our report on the Australian Academy of Science Fenner Conference on the Environment in the next edition of APC.

Reference

Martyn Yenson, A.J., Offord, C.A., Meagher, P.F., Auld, T., Bush, D., Coates, D.J., Commander, L.E., Guja, L., Norton, S.L., Makinson, R.O., Stanley, R., Walsh, N., Wrigley, D. and Broadhurst, L. (2021) *Plant Germplasm Conservation in Australia: strategies and guidelines for developing, managing and utilising ex situ collections. Third edition*. Australian Network for Plant Conservation, Canberra.

ANPC Project Manager (Germplasm Guidelines), Dr Amelia Martyn Yenson. Image: Michael Lawrence-Taylor

ANPC Member Profile

Meredith Cosgrove

What is your current position?

I am a contractor and freelancer based in Canberra, working on a wide range of botany-related projects.

What projects are you working on at the moment?

Victoria is currently updating the way it accounts for net gains or losses in native vegetation, and I'm part of a team working on developing the statistical models and tools for their new version of the gain calculator. This is important because we need to know how native vegetation responds to management regimes in order to protect it into the future.

I'm also working on a project to identify trees that will withstand and mitigate climate change for Bungendore Landcare in NSW. Being able to use my plant knowledge to help facilitate tree selection and plantings for climate change is one of the practical projects that I really enjoy being involved with.

I've started collaborating with ACT for Bees, a Canberra-based group with a strong emphasis on education and communication about all kinds of pollinators. ACT for Bees has been involved in the planning of Ginninderry, a suburb that has pollinator corridors embedded into its development plan. The corridors are laid out on a 200 x 200 m grid to match the flight distance of native bees. Insect health is critical to plant life cycles, so the integration of pollinator resources into urban developments is an exciting step toward sustaining plant-insect mutalisms.

How did you end up working in plant conservation?

Completely by accident. I had a background in horticulture but wanted to move into something different and I was lucky enough to get a job working at the ANU in the Nicotra Lab. I made a lot of dumb mistakes and learnt a lot. It shaped everything I do now. I went on to get a science degree and PhD in botany, which gave me skills I never would have learnt any other way. I always loved photography, and eventually I wrote two field guides using the photos I had. People like to know the nature around them, and we can't protect species if people don't recognize them. While I don't work directly in plant conservation, I do hope some of my work helps protect plants.

Meredith Cosgrove. Photo: Celeste Linde

What is your favourite plant and why?

No favourites! I think what I really like about plants is the landscapes they create and the incredible diversity of their forms and life cycles. From a centimeter to the globe, plants cover most of the planet, drawing down CO_2, releasing O_2, pumping water and feeding all life – very quietly. It's remarkable, but so ordinary that it's hard to hold in your mind for long. I think maybe the feeling of wonder that you experience in nature is the subconscious recognition of the reality made by plants.

To see some of Meredith's photos, you can visit her website at https://meredithcosgrove4706.zenfolio.com/p528090595

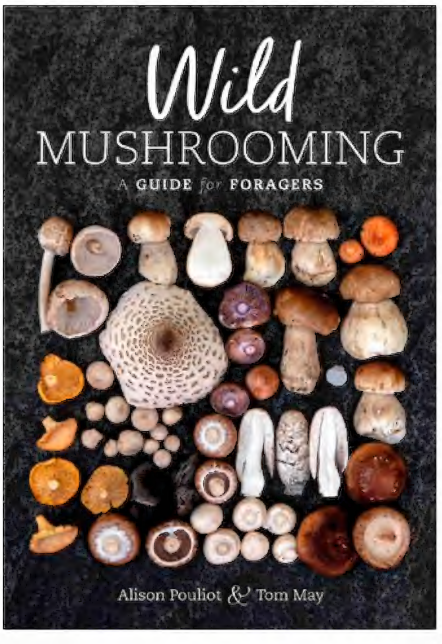
Why do you think the ANPC network is important and what do you see as our priorities?

We're at such a difficult point in history. Climate change is starting to impact everything. Fire frequency and intensity, irregular rain events, drought and increased temperatures are putting more and more pressure on more plant species. The ANPC's work in developing industry-standard guidelines are going to play an important role within the broader context of landscape conservation and renovation that is emerging.

Book review

Wild mushrooming: a guide for foragers

By Alison Pouliot and Tom May
Paperback | March 2021 | $ 49.99 | ISBN: 9781486311736 | 320 pages | 245 x 170 mm | Publisher: CSIRO Publishing
Colour photographs, Illustrations



At an initial skim, this book looked like a fantastic guide for expanding one's foraging skills and gastronomic experience. It starts with a lovely inclusive introduction, celebrating mushrooms and foraging across indigenous and global culture, and placing modern Australian foraging in a temporal and worldwide context. After a sensible explanation of fungi in general and context in Australia it quickly becomes wordy, with repetition being a common method employed to encourage caution. This is understandable, of course, nobody wishes to inspire the mushroom enthusiast to be casual about potential poisoning, but instead of enhancing focus, it becomes protracted. Perhaps more aimed at the established mushroom enthusiast looking to learn more about the edible fungus' place in Australia; it periodically tends towards a casual discourse discussing the background of wild mushrooms and concept of foraging with a little too much detail. Wild Mushrooming as a textbook would be too conversational, but it has depths of knowledge vastly unexpected in a guide. It reads like an enthusiastic professor who forgets to focus on the basics before throwing in half a dozen examples from six chapters ahead, and some data that are almost irrelevant. This could be a great bonus, if one is already an avid forager and keen for further details, but if it was an introduction for someone new it would be distracting. Once the reader is through amorphous discussions about foraging as a worldwide concept, the features and descriptions of poisonous sporophores are interesting and cautionary. The explanations of the edible fungi are clear, encouraging, and accessible, with pertinent toxic lookalikes attached to each relevant species. At the end is a selection of lovely recipes which felt like a delightful bonus unrelated to the first third of the guide.

I feel very mixed about this book, but I will happily recommend it to my friends as long as they do not actually read it word for word. There are paragraphs and chapters that are relevant and interesting, the occasional gems of humour are wonderfully relatable, the format is clean and mostly consistent, and the photography is exceptional. It would be a fantastic guide to read either lightly, for diagrams and explanations, or very deeply as it is clearly a passion project, but it feels to the newcomer as if it's been written to meet a page count.

News and conferences

ANPC News

Launch of the Third Edition of the Germplasm Guidelines

The third edition of '*Plant Germplasm Conservation in Australia – strategies and guidelines for developing, managing and utilising ex situ collections*' (also known as the Germplasm Guidelines) was launched on 7 September by Prof. Tim Entwisle during the online Australasian Seed Science Conference. See earlier article for more information. Lorraine Perrins of the Royal Tasmanian Botanical Gardens, a chapter author and case study contributor, described the guidelines as "one of the most useful and practical tools for the uncertain years ahead of us". Thank you to all 78 contributors who wrote the 15 chapters and 50 case studies and especially to ANPC Project Manager Dr Amelia Martyn Yenson who edited this edition. Thanks also to The Ian Potter Foundation for supporting the Germplasm Guidelines revision and publication.
Watch launch here **https://youtu.be/BbYNUCdL_Uw**
Download the e-version and order your hard copy here **https://www.anpc.asn.au/plant-germplasm/**

Australian Academy of Science Fenner Conference on the Environment: Exceptional times, exceptional plants

This free, online event funded by the Australian Academy of Science was held during the Australasian Seed Science Conference on 9 September 2021. The day attracted 306 registrations from 29 countries, with a mix of students, researchers, managers, genebank and botanic gardens staff and artists tuning in and contributing excellent questions and observations. The conference was opened by Dr Fiona Fraser, Acting Threatened Species Commissioner, with a keynote address from Prof. Hugh Pritchard. This was followed by presentations and a panel session on identifying and conserving non-orthodox species, particularly focusing on ex situ conservation strategies for Australian plants that cannot be conserved by conventional seed banking methods. As well as providing an opportunity for scientists to evaluate methods for conserving plant germplasm, it also gave participants a chance to strengthen partnerships and interact with experts online. Stay tuned for a full report in the next issue of APC. Recordings are available: **https://www.youtube.com/c/AnpcAsnAu/**

Plant Treasures

A series of videos is being produced to complement the new Germplasm Guidelines. Our video production team were at PlantBank in Sydney and the Australian National Botanical Gardens in May conducting interviews and obtaining footage for the videos. The first four videos premiered at the launch of the Germplasm Guidelines and the Fenner Conference in September. View the videos here **https://www.youtube.com/c/AnpcAsnAu/playlists**

Filming in the laboratory at PlantBank. Photo: Amelia Martyn Yenson

Healthy Seeds Project

The project team has finalised a 4-page summary of the *Healthy Seeds Roadmap - A strategic plan to improve native seed supply for ecological restoration in NSW* and a draft full report which is now available for review and feedback. The Roadmap provides a summary of the elements of the Healthy Seeds project, the findings of assessments on the status of the native seed sector in NSW, the issues and concerns raised in the process and the suggested direction and pathways to address these issues over time. It has been aligned with the national Greening Australia Project Phoenix Strategy.
https://www.anpc.asn.au/healthy-seeds/

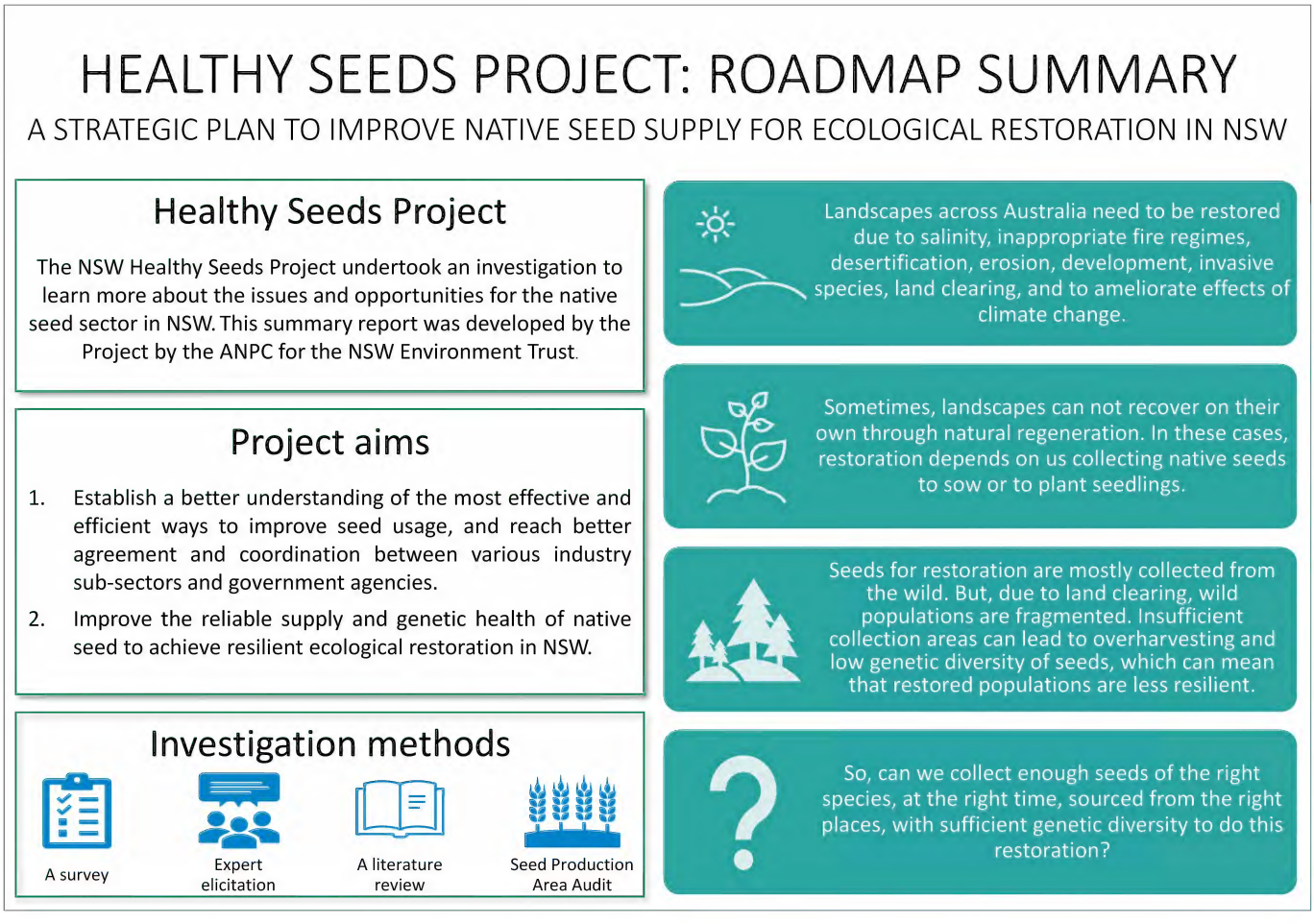
Florabank Guidelines released

The second edition of the *Florabank Guidelines – best practice guidelines for native seed collection and use* are now online and available for free download at **https://www.florabank.org.au/guidelines**. See earlier article for more information. The Florabank Guidelines are essential reading for anyone who works with native seed in any capacity from research to restoration, planting to policy and everything in between. This includes bush regeneration, tree planting, mine rehabilitation and landcare.

The Guidelines contain 15 modules which follow the native seed supply chain from collection, through processing to propagation and planting. To better support the whole of the seed supply chain, this update includes additional information on working with Indigenous Australians, approvals, record keeping, and tips for seed purchasers. ANPC Project Manager, Dr Lucy Commander, would like to thank the team of over 40 national and international collaborators who generously provided their time and expertise to update the Guidelines, and also those who reviewed the content. Thank you to Lucy for coordinating this enormous effort.

This revision was part of the Healthy Seeds Project funded by the NSW Environmental Trust and managed by the Australian Network for Plant Conservation (ANPC) Inc. The Florabank Consortium includes ANPC, Australian National Botanic Gardens, CSIRO and Greening Australia **https://www.anpc.asn.au/florabank/**

Watch Lucy's presentation 'Seed - getting back to Landcare's roots' at the 2021 National Landcare Conference in August through the Landcarer website recording: **https://landcarer-1.s3.ap-southeast-2.amazonaws.com/Landcare_Environment_seg10.mp4** Slides: **https://landcarer-1.s3.ap-southeast-2.amazonaws.com/6-Aug-2.05-Env-and-climate-change-Lucy-Commander.pdf**



Project Phoenix

The ANPC assisted Greening Australia reach a huge milestone in Project Phoenix. This project aimed to have the seed sector come together and develop the 10-year Native Seed and Landscape Restoration Strategy for Australia. ANPC Project Manager, Dr Martin Driver, was a member of the Project Phoenix steering committee, and helped drive the project. Project Manager, Dr Lucy Commander wrote three reports which inform the strategy. All 24 reports are available to the public, **https://www.greeningaustralia.org.au/project-phoenix-resources/**

Orchid Conservation Symposium held

The ANPC hosted an online symposium on Orchid Conservation in June, which was attended by 575 registrants from across 37 countries. See earlier article for more information. Eighteen speakers from Australia, the UK, South Africa, Germany and Hong Kong shared their research and experiences. Topics included orchid pollination, germination and translocation. We learned about new techniques and technologies including camera traps, as well as illegal orchid harvesting. Over one year since the 2019/20 fires, we heard about the effects of fire on orchid populations. We were treated to stunning photos of orchids across the globe including the Kimberley, where new species are still being discovered. A volunteer's eye view was presented and encouraged people to get involved in orchid conservation in their region. Recordings of selected presentations from the Symposium are available on our YouTube channel **https://www.youtube.com/playlist?list=PLuPMH5OJZz0HtWCL9kG75tnqDPFOFpzGm**

The ANPC would like to thank all the speakers for preparing such interesting talks, the Australian Government's Wildlife and Habitat Bushfire Recovery Program for funding both the Symposium and the larger project it was part of and the project leads, Ryan Philips, Noushka Reiter and Dan Duval. Also, a huge thankyou to the ANPC's Project Manager Lucy Commander, for seamlessly running both days.
https://www.anpc.asn.au/projects/preventing-extinction-in-bushfire-affected-orchids/

Saving threatened orchids from extinction

Since 2017, the ANPC has been working with the Royal Botanic Gardens Victoria (RBGV), Friends of the Grampians Gariwerd and the Australasian Native Orchid Society (Victoria Group) Inc. on two orchid conservation projects in western Victoria, to undertake surveys, collect seed, propagate seedlings, construct exclusion fencing and identify pollinators. Both projects culminated in June with the re-introduction of approximately 50 Audas Spider-orchid (*Caladenia audasii*) and 400 Brilliant Sun Orchid (*Thelymitra mackibbinii*) seedlings. Enthusiastic volunteers helped plant to supplement the low numbers of these threatened orchids in the wild. Both projects were funded by the Victorian Department of Environment, Land, Water and Planning through their Biodiversity On-ground Action grants.
https://www.anpc.asn.au/audas_spider-orchid/
https://www.anpc.asn.au/brilliant_sun-orchid/

RBGV Senior Research Scientist Dr Noushka Reiter planting an Audas Spider-orchid. Photo: N. Reiter

Banking on Seeds for Bushfire Recovery

The ANPC worked with the Australian Seed Bank Partnership (ASBP) on its project 'Banking on seeds for bushfire recovery.' See earlier article for more information. The project aims to limit the decline of 25 Australian plant species from areas affected by the 2019-2020 bushfires. This project included extensive activities in seed collection, reintroductions and germination trials. The ANPC prepared various communication materials to share the findings of this project. You can download a slideshow and six fact sheets on species that were part of the project from the ASBP website. **https://www.seedpartnership.org.au/initiatives/bushfire-recovery/banking-on-seeds-for-bushfire-recovery/**

Four Seasons of Seed

The second workshop in this series, run in collaboration with Murrumbidgee Landcare and Riverina LLS, 'Seed germination and propagation' was held in April. Around 25 participants attended from a wide geographic range, their interests included restoration of rare and diminishing species on their own land. The third workshop, held in July, was field based to inspect a range of direct seeded restoration and revegetation sites, equipment and techniques.

Seed germination and propagation workshop. Photo: Jade Auldist

13th Australasian Plant Conservation Conference 'Seeds to recovery' – Albury NSW, 3 to 7 April 2022

Save the date for our upcoming conference, be held in Albury NSW in April 2022. The themes for the conference are seeds, bushfire recovery, threatened species & communities, and engaging people with conservation & restoration. We are keen to partner with organisations, so please check out the partnership opportunities and get in touch. Call for Abstracts and Early-bird registrations are now open! **https://www.anpc.asn.au/conferences/apcc13/**

Plants Going Places

Filming took place in Melbourne in May to produce three videos (with accompanying podcasts) to explore the stories of past and current threatened plant translocation projects. These stories are told through the eyes of practitioners and investigate what makes a translocation successful. Our producer Chantelle Doyle and videographer Michael Lawrence-Taylor from the Plant Heroes team are investigating translocation projects of *Pimelea spinescens* subspecies *spinescens* (Spiny Rice-flower) in the Brimbank City Council area, *Microseris lanceolata* (Murnong/Yam Daisy) at Merri Creek and orchids in Victoria.

The first video and podcast are now available here **https://www.anpc.asn.au/plants-going-places/**. This video features the Spiny Rice-flower and explores learnings from mitigation translocations. What happens when a threatened plant is growing in an intended development location? Often under Australian legislation, impacts can be 'offset' and the plant translocated. Moved, salvaged, re-grown in pots and planted elsewhere. But does that really work? The Spiny Rice-flower is arguably Australia's most salvaged plant and has a few valuable lessons to teach - about ecology, collaboration and open accessibility of knowledge. Over 23 years the team has worked to improve success rates and sharing of outcomes that were once held as 'client in confidence', so that everyone involved in translocation has an opportunity to learn what has and has not worked.

Debbie Reynolds from Trust for Nature being interviewed for Spiny Rice-flower video. Photo: M. Lawrence-Taylor

Perth NRM Seed Collection Seminar

In June, ANPC Project Manager Dr Lucy Commander presented at a Perth NRM seminar. Lucy provided an overview of the new edition of the Florabank Guidelines, which outlines best practice native seed collection and use, as well as the Guidelines for the Translocation of Threatened Plants in Australia and a case study from her previous work restoring a Threatened Ecological Community. The seminar was fully booked, and well received, with attendees indicating that the seminar increased their knowledge about seeds and that they would share their new knowledge with colleagues and the community.

Lucy Commander presenting at the Perth NRM Seed Collection Seminar. Photo: Perth NRM

UN Decade on Ecosystem Restoration

The UN Decade on Ecosystem Restoration 2021 – 2030 was launched on World Environment Day, 5th June 2021. The decade aims to halt the degradation of ecosystems and restore them. Following a special session on NGOs and the UN Decade on Ecosystem Restoration at the Society for Ecological Restoration Australasia (SERA) Conference this year, at which Project Manager Lucy Commander presented on behalf of the ANPC, we have joined with 13 other Australian environmental organisations to form a consortium that supports the goals of the UN Decade in Australia. The consortium agreement, referred to as the 'Darwin Agreement', was initiated at the SERA2021 conference.
https://www.decadeonrestoration.org/
https://www.greeningaustralia.org.au/darwin-agreement-australasian-environmental-organisations-urge-support-of-un-decade-on-ecosystem-restoration/

Call for articles for 30th birthday edition of APC!

2021 marks the 30th anniversary of the ANPC!
The Summer edition of Australasian Plant Conservation will celebrate this milestone. Articles on the history of the ANPC and members' retrospectives over the last 30 years are encouraged, with a deadline of 1 November 2021. We are still accepting regular articles (including on issues relevant to plant conservation, and plant responses to fire) as usual, for the Anniversary Edition.
https://www.anpc.asn.au/apc/

Plant Cuttings – May 2021

Editors' note: News excerpts are clipped from a diversity of sources. To read the articles in full follow the links attached to each clipping. The views expressed in these articles are those of their authors and do not necessarily represent the opinion of the ANPC.

Mission to save Sydney's rarest eucalyptus species from extinction

When Steve Douglas was a budding ecology student, a quarter of a century ago, he discovered what turned out to be a new species of tree on a street corner just a few hundred metres from his home in Sydney's Hills District. **https://www.smh.com.au/environment/conservation/mission-to-save-sydney-s-rarest-eucalyptus-species-from-extinction-20210505-p57p4h.html**

Pretty please: How a bias against ugly plants could spell their doom

Imagine you're a junior ecologist about to embark on a career of research, or a politician about to dole out a wad of conservation cash, would you favour a charismatic species or one that is dull but more worthy of urgent help? **https://www.smh.com.au/environment/conservation/pretty-please-how-a-bias-against-ugly-plants-could-spell-their-doom-20210511-p57qrl.html**

Scientists are more likely to study bold and beautiful blooms, but ugly flowers matter too

We all love gardens with beautiful flowers and leafy plants, choosing colourful species to plant in and around our homes. Plant scientists, however, may have fallen for the same trick in what they choose to research. **https://theconversation.com/scientists-are-more-likely-to-study-bold-and-beautiful-blooms-but-ugly-flowers-matter-too-160601**

A stoush over a fire study and a chilling glimpse of the future

Today, a story about bushfires, the climate crisis, logging, and contested science. It's an important story, because it tells us about where our changing climate is taking us, and the very difficult choices we now face. **https://www.smh.com.au/national/a-stoush-over-a-fire-study-and-a-chilling-glimpse-of-the-future-20210511-p57qwx.html**

The race to rescue Australia's 50 most vulnerable plant species

The top of Mount Bogong in Victoria's high country isn't where you'd usually whip out a dustbuster, but senior botanist Neville Walsh has a pragmatic approach to plant conservation tools. **https://www.smh.com.au/environment/climate-change/the-race-to-rescue-australia-s-50-most-vulnerable-plant-species-20210511-p57qwf.html**

Push to save ancient trees from extinction

Sandalwood trees, while relatively common in parts of Australia, are on the brink of extinction in Victoria due to large-scale clearing. Now, locals in the state's north are stepping up efforts to make sure the trees, some of which are believed to be more than 500 years old, remain protected. **https://www.abc.net.au/radio/adelaide/programs/am/push-to-save-ancient-trees-from-extinction/13342446**

The 50 beautiful Australian plants at greatest risk of extinction — and how to save them

As far as odds go, things don't look promising for the slender-nerved acacia (*Acacia leptoneura*), a spiky plant with classic yellow-ball wattle flowers. With most of its habitat in Western Australia's wheat belt cleared for agriculture, it was considered extinct for more than 160 years. **https://theconversation.com/the-50-beautiful-australian-plants-at-greatest-risk-of-extinction-and-how-to-save-them-160362**

A touch of light: La Nina, government inertia and a tsunami of weeds

Alice Springs owes much of its uniqueness to the omnipresent power of nature, but too many of us expect nature to look after itself, to absorb and overcome all the shocks to the system of our unthinking behaviour delivered down the centuries. La Nina's rainfall bonanza of 2020-21 has a downside that exposes vulnerabilities in the natural environment and a legacy of chronic underspending by Government. **https://alicespringsnews.com.au/2021/05/16/a-touch-of-light-la-nina-government-inertia-and-a-tsunami-of-weeds/**

Social plants: in the wild, staghorn ferns grow in colonies to improve water storage for all members

Social colonies are nothing new in the animal kingdom. We know bees, ants and termites live in large colonies, divide labour and co-operate to take care of offspring produced by a single queen. **https://theconversation.com/social-plants-in-the-wild-staghorn-ferns-grow-in-colonies-to-improve-water-storage-for-all-members-156377**

Scientists discover 'remnants of ancient rainforests' in path of Coffs Harbour bypass development

Millions of years ago, lush rainforests blanketed the massive Gondwana supercontinent encompassing Australia, Antarctica and South America. From those forests, the first flowering plants evolved. **https://www.abc.net.au/news/2021-05-21/rare-plant-species-found-near-highway-coffs-harbour-nsw/100149038?utm_campaign=news-article-share-control&utm_content=mail&utm_medium=content_shared&utm_source=abc_news_web**

Highway threat to irreplaceable ancient plants

Millions of years ago, the first flowering plants evolved from the flush rainforests that blanketed the massive Gondwana super continent. A tiny patch of descendants from two of those ancient species has just been discovered in New South Wales, but there are concerns about their future. **https://www.abc.net.au/radio/programs/am/highway-threat-to-irreplaceable-ancient-plants/13353564**

Easy to plant natives

Whether you want a conga line of wildlife, or just a butterfly or two, native plant enthusiast Linda Niemann joins Jon Lamb and Deb Tribe with her suggestions on simple ways to add natives to your garden to attract local wildlife. **https://www.abc.net.au/radio/adelaide/programs/saturdaybreakfast/talkback-gardening/13355342**

'Just fantastic': Wollemi pine replanting effort wins global gong

A secret project to increase the odds of the Wollemi pine surviving in the wild has won international recognition from conservation groups hoping the lessons learnt will help pull other threatened species back from the brink of extinction. **https://www.smh.com.au/environment/conservation/just-fantastic-wollemi-pine-replanting-effort-wins-global-gong-20210526-p57vel.html**

Preserving the Wollemi pine

Threatened species ecologist, Berin Mackenzie, has been toiling on a project known only to a few close colleagues. In the process, interrupted by the Black Saturday bushfires, Mackenzie and his team have added to the storied efforts to preserve the Wollemi pine. [Image gallery] **https://www.smh.com.au/national/nsw/preserving-the-wollemi-pine-20210528-h1w47g.html**

'Real sense of achievement': The next step to preserve the Wollemi pine

Berin Mackenzie is used to hauling heavy loads, lugging 30-kilogram packs up and down remote canyons, with a 10-kilogram bucket in his free hand and the other gripping a taut rope. But his burden hasn't merely been a physical one for the last few years. **https://www.smh.com.au/environment/conservation/real-sense-of-achievement-the-next-step-to-preserve-the-wollemi-pine-20210526-p57vef.html**

The wattle war

It's the green and gold of our sporting uniforms, the blaze of yellow wrapped around our coat of arms, and its seeds have provided bush food for millennia. Wattle — scientific name Acacia — is Australia's much-loved national flower. But across the Indian Ocean, Africa calls acacia its own too ... and their relationship with this iconic plant runs just as deep. **https://www.abc.net.au/radionational/programs/sciencefriction/acacia-name-africa-australia-wattle-war-botany-taxonomy/13372220**

New ideas challenge traditional views about plant conservation and restoration

The region around south-west Western Australia is known as a biological hotspot. It contains high diversity with many species found in small pockets. The landscapes are ancient and have existed with a stable climate due to the influence of the large Indian Ocean. Many theories about plant conservation come from the northern hemisphere where landscapes are young. Now scientists in Brazil, Australia, California and south Africa are challenging traditional views with new ideas about conservation and restoration appropriate to older landscapes. As Stephen Hopper explains, with this rich biodiversity comes increased sensitivity. Species offer low resilience to disturbance. Landscapes impacted by machinery or human recreation such as trail bikes can be damaged quickly and irreparably. **https://www.abc.net.au/radionational/programs/scienceshow/new-ideas-challenge-traditional-views-about-plant-conservation/13384122**

Rare orchids found in City of London bank's rooftop garden

A colony of rare orchids has been discovered growing on the rooftop of an office building in the City of London. It is the first time the small-flowered tongue-orchid has been seen in the UK since arriving in Cornwall in 1989. **https://www.bbc.com/news/uk-england-london-57439921**

Botanists biased towards pretty plants more than the uglies

Lockdowns around the world have stopped field trips. So how about some desktop research! Botanist Kingsley Dixon in collaboration with his locked down colleagues in Europe looked at the plant species from the European Alps of the southwest studied by botanists since 1975. There was a clear trend. How do botanists explain this clear bias towards the pretties? **https://www.abc.net.au/radionational/programs/scienceshow/botanists-biased-towards-pretty-plants-more-than-the-uglies/13399050**

Kings Park Botanic Garden Perth great for a stroll with top-notch botanical and horticultural research

Kings Park Botanic Garden Perth is perched high on a plateau overlooking Perth. Robyn Williams visits and hears about the range of botanical and horticultural research being carried out. Research scientist Carol Elliott specialises in rare plants. Carol and her colleagues advise mining companies when they remediate land after mining operations cease. Plant Breeder Digby Growns describes work on extending the life of cut flowers, and the development of new varieties of native plants more tolerant to the conditions found in suburban gardens. The new blue kangaroo paw should be available towards the end of 2021. **https://www.abc.net.au/radionational/programs/scienceshow/kings-park-botanic-garden-perth-great-for-a-stroll-and-does-top/13399056**

Eucalypts in a time of climate change

Throughout the Australian continent's history, the Eucalypt has been there… for millions of years. The remarkable and resilient species continues to withstand intense fire, severe droughts, and overwhelming rains. But increasingly, we're seeing Eucalypts in a state of transition, with the impacts of climate change forcing the species to adapt again. **https://www.abc.net.au/radionational/programs/blueprintforliving/blueprint-living-with-eucalypts-amid-climate-change-greg-moore/13395822**

Australia or Africa? The botanical controversy over who can call their plants 'Acacia'.

As chilly winds sweep across south-eastern Australia, the first wattles of the season are preparing to burst into fluffy pom-poms of resplendent gold and pale cream. Wattle — scientific name Acacia — is synonymous with this land. Yet Australia is not alone in having a deep connection to acacias. **https://www.abc.net.au/news/science/2021-06-20/acacia-name-debate-botany-taxonomy-africa-australia-plants/100221938**

NSW losing Sydney CBD-sized chunk of tree cover every two days to clearing

NSW lost the equivalent of Sydney's CBD to clearing for farming, forestry and other uses in 2019 every two days, continuing the accelerated deforestation pace that followed the loosening of native vegetation laws. **https://www.smh.com.au/environment/conservation/nsw-losing-sydney-sized-chunk-of-tree-cover-every-two-days-to-clearing-20210629-p58564.html**

Will your grandchildren have the chance to visit Australia's sacred trees?

Trees have always been a point of conflict between colonisers and Indigenous people. At the very beginning of European-Indigenous interactions, skirmishes broke out because colonisers were ignorant of protocols and the desecration of important Indigenous sites and habitats. In the 19th century, as frontiers pushed west into the Country of Wiradjuri, colonists were indifferent to the sanctity of marked trees. **https://theconversation.com/will-your-grandchildren-have-the-chance-to-visit-australias-sacred-trees-only-if-our-sick-indifference-to-aboriginal-heritage-is-cured-163581**

How indoor plants can creep outside and cause havoc

We're spending more time at home with many of us are trying to create peaceful, calm spaces, bringing a piece of nature to our living-rooms, kitchens and newly created home offices. But how much do we know about the plants we grow? It turns out that our plants can escape and turn into invasive weeds that pose a threat to Australia's unique ecosystems and habitat for wildlife. **https://www.abc.net.au/radionational/programs/drive/how-indoor-plants-can-creep-outside-and-cause-havoc/13443576**

Cactus-traffickers are pushing rare plants to extinction

While there is international concern about wildlife trafficking pushing endangered species such as rhinos, tigers and pangolins to the brink of extinction, few people are aware of the multi-million-dollar black market trade in exotic plants. A huge cactus bust in Italy, which resulted in the confiscation of over 1,000 rare cacti smuggled out of Chile's Atacama Desert, highlights the thorny issue of plant poaching. **https://www.abc.net.au/radionational/programs/latenightlive/cactus-trafficking-is-pushing-rare-plants-to-extinction/13425172**

Most of Australia's threatened plants aren't being monitored, increasing the risk of extinctions

Most of Australia's threatened plants aren't being monitored, increasing the risk of extinctions. Almost two-thirds (63%) of threatened Australian plants are not receiving any monitoring according to a recent national assessment published in Biological Conservation. **https://www.nespthreatenedspecies.edu.au/news-and-media/media-releases/most-of-australia-s-threatened-plants-aren-t-being-monitored-increasing-the-risk-of-extinctions**

Fabulous Ferns

Ferns are fabulous additions to gardens. Wayne Richards, President of the SA Fern Society, joins Jon Lamb & Deb Tribe with loads of advice on what ferns to plant and how to care for them. Turf consultant Stefan Palm tackles moss and algae in pavers. **https://www.abc.net.au/radio/adelaide/programs/saturdaybreakfast/talkback-gardening/13468980**

Red Cedar

Red cedar (*Toona ciliata*) was so valued by woodworkers that in the late 1970s a scheme to pluck individual trees from Queensland rainforests was considered. Dr Greg Moore tells Jacinta Parsons that the plan didn't end up going ahead. **https://www.abc.net.au/radio/melbourne/programs/afternoons/greg-moore-on-red-cedar/13472276**

Fungi fossicker discovers 'highly significant' orchid species in Gold Coast hinterland

A fungi enthusiast has helped identify a new species of orchid during a hike in the Gold Coast hinterland. Meredith Philistin took a photo of the unusual plant and sent it to her friend, Joanne Lau, who is an orchid enthusiast.
https://www.abc.net.au/news/2021-07-28/new-orchid-species-discovered-in-gold-coast-hinterland/100322870

Bushfire brings an unexpected gift as creek bed is rejuvenated 16 years on

Farmer John Cook lost sheds, machinery, historic stone buildings, fences, and 500 sheep in the Black Tuesday Wangary bushfire in 2005. He lost valuable vegetation lining a creek but it regenerated. **https://www.abc.net.au/news/2021-07-19/bushfire-brings-an-unexpected-gift/100299088**

Events and Opportunities

Combined NSW and VIC Weeds Conference – 21-24 March 2022, Albury NSW (new dates)

Jointly supported by the weeds societies of New South Wales and Victoria – weeds without borders, the Conference will be held in the Albury Entertainment Centre from 21-24 March 2022. The conference will focus on skills development, recognition and has planned four field trips. Early bird registrations are open until 25 February 2022. For more information see **https://www.nswweedsconf.org.au/**

Research round up

TOM LE BRETON
University of New South Wales

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